UNIVERSIDADE DE LISBOA

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The Reform of the Portuguese Pension system: a Micro-simulation Approach

Luis Pedro de Oliveira Garcia e Pina Manso

Orientador: Prof. Doutor Amílcar Moreira

Tese especialmente elaborada para obtenção do grau de Doutor em

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I. Aknowledgements

This work would not have been possible without the guidance and patience of my thesis advisor Ph.D. Amilcar Moreia. Further, the development of the DYNAPOR model was covered by a joint financing venture of the Fundação Francisco Manuel dos Santos and the Fundação Calouste Gulbenkian.

Last but definitely not least, nobody has been a bigger influence in the completion of this project than my family. I would like to thank my mother, which has always believed in my ability to achieve anything that I set my mind into. Without her love none of this would have been possible. I would like to thank my brother that has always encouraged me to move forward in this endeavour. I would like to thank Joana for her patience and support and for enduring during this time. You are the greatest woman I have ever met and provide me with daily inspiration. Finally, I would like to dedicate this thesis to my late father, whose love I still feel today in the eyes of all of those that knew him.

II. Declaration of authorship

The DYNAPOR model (Moreira et al. 2018) was developed from the MIDAS_BE model (Dekkers et al. 2009, Dekkers et al 2015, Dekkers and Van den Bosch 2016). The model runs on LIAM2 (De Menten et al. 2014), a Python-based platform which is used for developing and running dynamic microsimulation models.

In addition to adopting the architecture of MIDAS_BE, a number of key features were kept. Some key simulation processes in the Demographic block - such as family formation and dissolution routines - were retained , or were subject to minimal changes to better reflect specificities of the Portuguese society - as was the case of the mortality, fertility, educational attainment routines (see Moreira et al, 2018 forthcoming). In order to better reflect the specificities of the Portuguese labour market and of the Pension system, a number of changes was introduced to the MIDAS_BE Labour Market simulation block. Unlike MIDAS_BE, where the take-up of a pension triggers a transition into retirement, in DYNAPOR a person can receive a pension and still remain in work. Some labour market status in MIDAS_BE (namely those in early-retirement) were eliminated as they found no correspondence in the Portuguese labour market. Furthermore, public sector workers were divided into two groups: those covered by social security and those covered by the Civil Servants Pension scheme (Caixa Geral de Aposentações) – which is a closed group (see Moreira et al, 2018 forthcoming). On the other hand, all simulation routines that are meant to simulate pension and tax rules from the Belgium welfare system were replaced.

The alignment procedures are largely based on the procedures used in the MIDAS_BE, and were adapted to suit the specificities of the Portuguese context. More specifically, new alignment procedures were introduced to model transitions in and out of work (as to reflect the approach adopted to model transitions to retirement), to model transitions to disability (which differentiate transitions by the degree of disability), and model transitions in and from public sector work and civil service (see Moreira et al, 2018 forthcoming). In what concerns the MIDAS_BE's Parameters Table, all parameters used to simulate pension and tax rules from the Belgium welfare system dropped.

Parameters for key macro-economic variables (such as GDP or Labour Productivity) were kept, but imputed with data for Portugal. New parameters were created to simulate Portuguese pension and tax rules (see Moreira et al, 2018 forthcoming).

The work of developing DYNAPOR from MIDAS_BE was conducted by a team of researchers at the Institute of Social Sciences (University of Lisbon), coordinated by Amilcar Moreira which includes myself, Alda Azevedo and Rui Nicola (registered for a PhD at the University of Southampton). While this was a fundamentally collaborative process, the modelling pension and tax rules was conducted as follows:

a) Rui Nicola was solely responsible for modelling the eligibility, entitlement rules, parametrization and validation of the Old Age Pension (Social Security System), of the Early-Retirement Scheme for Long Careers (Social Security System), the Early Retirement for Long-Term Unemployed Persons (Social Security System) and the Social Old Age pension, including the imputation of contributory careers and registered remunerations using administrative data. He was also responsible for preparing the macroeconomic parameters and projections for Portugal, by introducing official data when available and adjusting the convergence period towards the AWG projection figures, as well as setting the parameters table to be run in a constant prices model;
b) Amílcar Moreira and I were responsible for modelling in the Personal Income Tax rules, and Social security Contributions;
c) I was responsible for modelling the eligibility and entitlement rules of Survivors' Pension (Social Security System), Disability Pension (Social Security System), Social Solidarity Compliment, Old Age Pension (Civil Servants System, CGA), Survivors' Pension (Civil Servants System, CGA);
d) I was solely responsible for modelling the NDC pension schemes for each of the various scenarios developed in this thesis.

Finally, the model description used in this thesis is follows closely on the description found in Moreira et al. 2018 (forthcoming)

III. Abstract

This thesis uses a Dynamic Microsimulation Model (DYNAPOR) to analyse the impact of a transition from a traditional Defined Benefit Pay-As-You-Go pension scheme to a Notional Defined Contribution system on both the financial and the social sustainability of the pension system in Portugal. The results show that while the NDC scenarios outperform the DB-PAYG system in terms of financial sustainability, it does so at cost of the social component. Additionally, the various features of the NDC pension system are proven to be essential in both curbing expenditure and improving adequacy and poverty alleviation.

IV. Resumo

Esta tese utiliza um modelo de micro-simulação dinâmico (DYNAPOR) para analisar o impacto económico, financeiro e social da transição de um sistema de pensões pay-as-you-go de benefício definido para um sistema de contas nocionais em Portugal. Utiliza o modelo DYNAPOR para simular quatro cenários diferentes. Os resultados obtidos sugerem que uma transição para um sistema de contas nocionais semelhante ao que está em vigor na Suécia se traduz num melhoramento significativo da sustentabilidade financeira em relação ao previsto no sistema atual. Contudo, este melhoramento na sustentabilidade financeira acontece em detrimento da componente social do sistema de pensões. Mais, o impacto da componente redistributiva e de balanço automático do sistema NDC no alívio da pobreza e da despesa é comprovado pelos resultados.

V. Resumo Alargado

Durante as ultimas décadas do século XX, vários países implementaram alterações profundas ao seu sistema de pensões. A maioria destas alterações foi derivada de um conjunto de ameaças que é comum à maioria dos sistemas de pensões definidos como pay-as-you-go: o envelhecimento da população; o baixo crescimento económico; e o desequilíbrio fiscal. Este conjunto de elementos forma uma receita desastrosa que tem vindo a contribuir para o aumento da despesa relacionada com pensões em conjunto com uma diminuição nos recursos de financiamento das mesmas.

Resultante destas preocupações, muitos países têm respondido através de um ajustamento dos parâmetros do seu sistema de repartição de benefícios definidos (PAYG-DB), tais como:

um aumento do nível das contribuições para a Segurança Social; um aumento da idade de reforma ou até uma indexação da mesma numa tentativa de ajustar "automaticamente" as pensões às tendências demográficas, como o envelhecimento por exemplo; também se têm usado outros ajustes com o objetivo de melhorar a sustentabilidade financeira do seu sistema de pensões. Por outro lado, alguns países têm vindo a optar por uma mudança estrutural, onde alteram os princípios reguladores e o *design* do regime de pensões. É aqui, entre este tipo de reformas estruturais, que encontramos as transições para os sistemas de contas nocionais (NDC).

Esta abordagem veio para a ribalta entre 1994 e 1998, quando a Suécia reestruturou completamente o seu sistema de pensões, optando por um novo sistema que combinava aspetos do sistema de capitalização integral com aspetos do sistema de repartição de benefícios. Na sua essência, os sistemas de pensões de contas nocionais são muito semelhantes aos sistemas de repartição de benefícios. Na verdade, partilham o mesmo tipo de financiamento. Contudo, o valor do benefício é definido de acordo com as regras dos sistemas de capitalização integral. Tal como num sistema de repartição, um sistema de contas nocionais é financiado através das contribuições atuais. Como o próprio nome sugere, num sistema de contas nocionais não existe acumulação de capital, como seria de esperar de um sistema de capitalização integral. Em vez disso, as contribuições são utilizadas para cobrir despesas correntes e um valor "nocional" é creditado na conta individual. Por sua vez, quando um individuo atinge a idade de reforma, o valor da sua conta nocional é convertido numa anuidade, tendo por base a esperança de vida de acordo com a idade em que reformou.

Existem vários argumentos em prol de uma transição para um sistema de pensões constituído por contas nocionais. Em primeiro lugar, existe o conceito de 'justiça'. Na maioria dos países

com um sistema de repartição de benefícios, a fórmula utilizada para calcular o valor da pensão tem em conta o salário no final da carreira de um individuo. Como resultado, esta fórmula é mais vantajosa para indivíduos que possuem perfis de rendimentos mais elevados. No âmbito de um sistema de contas nocionais este problema é fundamentalmente eliminado, retirando-o do pilar principal do sistema e adicionando um pilar complementar, cujo único foco é a redução da pobreza. Neste sistema, as pensões de velhice são um produto direto de contribuições individuais. Quanto mais um individuo contribuir, maior será a sua pensão, implicando um maior grau de imparcialidade, quando comparado com sistemas de repartição. Em segundo lugar, o estreitamento do elo de ligação entre contribuições e as pensões geradas fornece um grande incentivo para que os indivíduos trabalhem por períodos de tempo mais prolongados, aumentando a responsabilidade individual do sistema e retribuindo o esforço individual. Em terceiro lugar, sistemas de contas nocionais asseguram um equilíbrio de longo prazo entre pagamentos de pensões e contribuições, contribuindo para a sustentabilidade do sistema. Em quarto lugar, uma vez que a taxa de retorno é determinada através do crescimento dos salários ou do crescimento económico global, em vez de atribuir um retorno sobre ativos financeiros específicos, protege os indivíduos contra flutuações de mercado a curto prazo. Este tipo de proteção é habitualmente associado a sistemas de capitalização integral. Por fim, e talvez um dos argumentos mais relevantes para os países que pretendem implementar uma reforma estrutural para um sistema de contas nocionais, uma transição para um sistema de contas nocionais é mais simples e implica menos custos do que uma reforma para um sistema de capitalização. Tendo em conta que uma reforma do sistema de pensões para um sistema de contas nocionais não implica custos associados com um financiamento de benefícios, esta opção apresenta um pacote de reforma

muito atrativo para países que pretendam transitar para um sistema de capitalização, utilizando esta reforma como um período transitório, sem custos associados.

Outro aspeto que vale a pena mencionar e que fundamentalmente certifica a legitimidade dos regimes de contas nocionais é o facto de que neste sistema existe uma grande diminuição da necessidade de intervenção do governo como organismo regulador. Uma vez que os ajustes paramétricos do sistema são feitos, na sua maior parte, de forma automática, as entidades reguladoras podem ter uma abordagem mais leve, o que poderá, eventualmente, levar a uma redução de custos de gestão do sistema e um aumento da credibilidade politica do sistema. Em termos gerais, os sistemas de contas nocionais são menos propícios a alterações e pressões políticas geralmente associadas com os sistemas de repartição.

Na sequência destes argumentos a favor de sistemas de contas nocionais, a questão central que orienta esta tese é: pode uma reforma do sistema de pensões em Portugal para um sistema de contas nocionais melhorar a sua sustentabilidade financeira, fiscal e social? Para responder a esta questão, será simulada a transição para um sistema de contas nocionais em Portugal através de um sistema de Micro-Simulação Dinâmica (DYNAPOR). A utilização de um modelo de micro-simulação dinâmica é justificado pela natureza da investigação desta tese. Graças à complexidade dos resultados produzidos por este tipo de modelo, é possível analisar o impacto de uma alteração no sistema, diretament na distribuição de pensões, na pobreza dos pensionistas e na sustentabilidade do sistema. Deste modo, é possível analisar todas as componentes presentes na nossa questão em investigação, nomeadamente a questão financeira, fiscal e social.

Para este efeito, este projeto foi dividido em 8 capítulos. O primeiro capítulo será uma breve introdução dos sistemas de contas nocionais, os objetivos dos sistemas de pensões e a sua

relevância no caso Português. O segundo capítulo constitui uma análise histórica do sistema de pensões em Portugal que vai desde as primeiras misericórdias em 1949 até ao sistema de repartição que se encontra hoje em prática. O Terceiro capítulo é constituído por uma análise da situação atual do sistema de pensões em Portugal. Esta secção inclui uma análise da sustentabilidade do sistema de pensões tendo por base a sua sustentabilidade financeira e o conceito de "adequacy" das pensões. O quarto capítulo desta tese será uma análise de três tipos de transições para um sistema de contas nocionais. Para este capítulo foram escolhidos os sistemas de pensões Sueco, Polaco e Italiano. O quinto capítulo constitui a justificação da metodologia utilizada assim como uma descrição do modelo DYNAPOR. Ainda no quinto capítulo será apresentada uma proposta de um modelo de contas nocionais para adotar no contexto Português. O sexto capítulo constitui um desenvolvimento do processo de decisão de reforma de cada individuo no modelo DYNAPOR. Uma vez que a janela de idades de reformas nos sistemas nocionais é muito maior do que aquela que existe no sistema de repartição em Portugal, é necessário desenvolver um processo mais elaborado do que aquele que existe de momento no DYNAPOR para simular a decisão individual de reforma ao abrigo do novo sistema. Finalmente, no sétimo capítulo será elaborada a análise da transição para o sistema de pensões de contas nocionais. Por último, as secções oito e nove desta tese contém a discussão e a conclusão.

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Chapter 1: Notional Defined Contribution Systems: The need for pension reform in Portugal

1.1. Background[1]

1.1.1. Introduction

The current public pension system in Portugal is characterized as a Defined-Benefit Pay-As-You-Go (DB-PAYG) system. Currently, this is the type of pension arrangement that prevails in most developed countries. In spite of its widespread coverage across the EU, this type of pension system is often exposed to exogenous factors, which has led to concerns regarding its sustainability (Boeri & Galasso, 2010). For instances, the last few decades have been characterized by a period of declining fertility and increasing longevity, which inherently led to an ageing of the total population. In fact, Portugal has experienced an increase of 10 points in the Old-Age Dependency Ratio[2], from 20.3 in 1990 to a 32.1 in 2016 (EUROSTAT, 2018). Additionally, recent projections by the European Comission (2018) show an expected increase in the Old-Age Dependency Ratio from 32.1 in 2016 to a staggering 67.2 in 2070. Overall this means that there would be approximately 67 individuals aged 65 and over per 100 individuals of working age.

A quick analysis of this indicator clearly illustrates the strain that population ageing places on the financing of the pension system in Portugal. For instances, imagine there is a country that is composed by 100 individuals, all older than 15 years old, with an old age dependency ratio of 33. If we assume that all individuals of working age are employed and all individuals aged 65 and over are receiving a pension, this means that there are approximately 3 individuals financing 1 pension. On the other hand,

[1] The development of the DYNAPOR model has been financed by the Fundação Francisco Manuel dos Santos and the Fundação Calouste Gulbekian.

[2] According to the OECD (2017), the old-age dependency ratio refers to the ratio of individuals aged 65 years and over to the working population, defined as individuals aged between 15 and 64 years old. This indicator is presented as the number of old age individuals per 100 individuals in working age.

if we assume the scenario presented in the 2018 Ageing Report (European Comission, 2018), this would mean that there would approximately 1.5 individuals financing 1 pension. Further, this is an optimistic illustration that assumes a full employment rate, which in reality is not the case. Just as eloquently described by Börsch-Supan (2003), the European economies face two deeply rooted macroeconomic factors that contribute to the financial imbalance of the pension system: high levels of unemployment and slow economic growth. As previously illustrated, a high unemployment-rate may contribute to an extra burdening of the system, since some individuals that are of working age may be unable to contribute and, in some cases, may even draw resources from the system in the form of benefits that are aimed to protect individuals against a loss of income due to unemployment.

Adding to the points described, it is important to note that as the system achieves its maturity[3] individuals will be reaching the age of retirement with longer careers and higher contributions, which in turn gives entitlement to higher pension and contributes to the increase in pension expenditure (World Bank, 1994a). In line with this argument, data from the Portuguese National Institute of Statistics (INE) shows that in the last decade, there has been an increase of approximately 60 percent in pension expenditure as percentage of GDP, from 9.24 percent in 1995 to 14.94 percent in 2015.

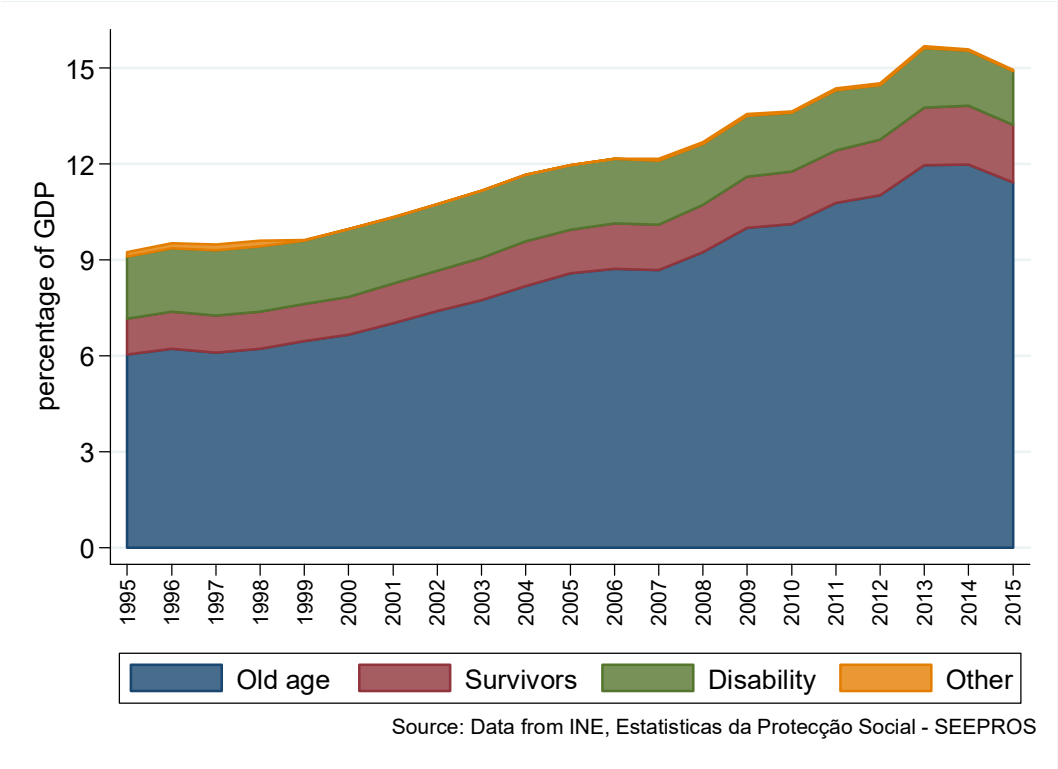
Finally, the number of old age pensioners has been increasing exponentially in the past two decades. According to data from the MTSSS[4], the total number of pensioners in Portugal as a percentage of total population has also experience a considerable increase in the last few years, from 23.38 percent in 1995 to 29 percent in 2015. Additionally, the 2015 Ageing Report projections show an expected increase of approximately 11.5 percent in the total number of pensioners. It is important to note that most of the increase in the total number of pensioners has been led by an increase in the number of old age pensioners, while the number of survivors pensioners as a percentage of total population has

[3] In its famous title "Averting the Old Age Crisis", the World Bank (1994) defines pension system maturity as the process in which young people who are eligible for pensions, in a new system, gradually grow old and retire, thereby raising the system dependency ratio to the demographic dependency ratio. In a fully mature system all old people in the covered group are eligible for full pensions .

[4] Ministry of Labour, Solidarity and Social Security

either remained relatively stable or, in the case of disability pensioners, has even declined. As expected, in terms of expenditure these proportions are represented accordingly, with old age pensions representing the majority of pension expenditure, which in turn, has been increasing over the past few years (*Figure 1*).

Figure 1 Pension expenditure by type of pension in Portugal, 1995-2015



As described, there are a number of factors that may impact on the ability of the pension system to remain financially stable. From this analysis, it is correct to assume that the future of the Portuguese pension system remains mostly uncertain. Independently of the forecasts, policymakers are unable to accurately predict how population ageing, economic growth or even unemployment will develop in the following years. Consequently, the final decades of the twentieth century were marked by a surge of pension reforms. The primary reason for these reforms has mostly been to address the financial imbalances that have risen as a consequence of population aging (Hering, 2006).

1.1.2. Objectives of a Pension System

In order to provide a better analysis of what pension reforms are and what is the most appropriate course of action in the quest for a sustainable pension system, it is important to look at the objectives of the pension system. For instance, if there is a shortage of contributions, one could achieve financial sustainability by simply cutting back the generosity of old age pensions. However, this type of measure would be in conflict not only with the objectives of the pension system by the actual social contract that guides the system altogether. The purpose of a pension system, be it PAYG or pre-funded, public or private, is to transfer contributions from current workers to current retirees (Barr, 2002). According to Barr and Diamond (2006), income security in old age is based on two types of instruments: a mechanism for consumption smoothing and a means of insurance. First, the authors argue that individuals do not save because they value extra consumption at a single point in time. Instead, individuals value consumption through the course of their life-time. Therefore, one of the main purposes of an old age pension is that it allows individuals to transfer consumption from their most productive years to their retirement years (Koetsier, 2017). This way, individuals ensure that they will be able to maintain a certain level of consumption that is closer to the one they experienced in their peak years. This first instrument makes pension systems unlike any other type of government expenditure. For example, in terms of expenditure on education, there should not be a disparity between expenditure per individual based on income levels (Schwartz, 2006). Everyone should have the right to the same level of education independent of their position in the income strata. From a pension system perspective, assuming that individuals have different levels of consumption based on their level of income, the objective of consumption smoothing is unevenly distributed in terms of resources.

Second, Barr and Diamond (2006) stress the importance to consider that there is a considerable degree of uncertainty that pertains to the life of any individual. People face uncertainty on a daily basis, including the length of their life. This creates a problem where individuals may either outlive their pension savings or be “too” careful and spend too little. However, Barr and Diamond (2006)

argue that, while the life expectancy of a single individual may be hard to predict, it is simpler simpler to consider the group to which the individual belongs to. In essence, an individual pension should be paid by taking into consideration both the amount the individual as contributed during a lifetime as well as the life expectancy of the group to which the individual belongs to. As a result, the risk from longevity is shared by all members of that particular group (Fehr & Habermann, 2004).

From a financing point of view, it is clear to see that the essence of a pension system rests in intergenerational transfers from young to the old. Current workers sustain current beneficiaries in the expectation that when they reach old age, future workers will finance their pensions as well. Additionally, the risk of longevity does not rest on a single individual, but instead on a group of individuals, which by sharing make it less threatening at the individual level. While consumption smoothing and insurance are often considered the main objectives of pensions, these do not stand alone. Further objectives of old age pensions include poverty reduction and redistribution. Despite the four objectives enunciated here, it is important to note that there should not be a stratification in terms of the importance of old age pension objectives. Instead, each objective represents societal priorities that are country specific. Therefore, if a country places more emphasis in poverty reduction than redistribution, this may be a reflection of their own context and societal needs (Schwartz, 2006).

1.1.3. Public Policy Implications

As demonstrated in point 1.1.1., the last few decades have been characterized by a change in the demographic and financial context of the pension system in Portugal. It appears that trends of population ageing have resulted in an increase of the number of pensioners, which in turn has translated into an increase in the level of expenditure, mostly led by expenditure in old-age pensions. In light of these difficulties, policymakers all over world have been re-defining what pension systems should seek to achieve, and they have done so in quite a variety of ways. This section will consider pension reform in light of three main objectives: sustainability, adequacy and actuarial fairness.

The previous decades were characterized by transformations of the pension systems in several European countries. The importance of fiscal sustainability of the pension systems came into the spotlight during the 1990s with the publication of the World Bank's report "*Averting the Old Age Crisis* in 1994". This report has not only sparked interest for the sustainability in financial terms but also in terms of adequacy[5]. The ever changing and intrinsic nature of our social context calls for a comprehensive social protection system that provides adequate protection while ensuring its very own fiscal sustainability.

While the primary objective of pension reforms is often to ensure the sustainability of the pension system, the impact of these reforms cannot be simply considered from a fiscal point of view. By doing so, it would ignore the main objective of a pension system, which is to provide income security in old age (Barr, 2013). For instance, in Portugal, the objective statement of the Social Security Institute clearly states that one of its primary objectives is to "promote the sustained improvement of the levels and conditions of social protection, as well as to reinforce equity" (Social Security Institute, 2018). As such, it appears that to consider only the fiscal sustainability of the system seems to fall short of an accurate evaluation of pension reform. In his work, Barr (2013) decomposes the purpose of a pension system into four elements: consumption smoothing, insurance, poverty relief and redistribution. In this sense, it is clear to see that more works on the impact of pension reforms are beginning to broaden their scope of analysis, going beyond the notion of improvement in its simplistic form of fiscal sustainability and converging towards a bigger consideration of adequacy – alongside sustainability – as a more effective way to analyse the impact of pension reform. This broader scope of analysis of the pension system is made evident in the work of Holzmann and Hinz (2006), where an adequate pension system is defined not solely with regards to their fiscal sustainability, but also as a system providing

[5] According to the European Comission (2016), The adequacy of pensions is measured by their ability to revent poverty, the degree to which they replace income before retirement and how they compare to the average incomes of people below pensionable age.

benefits “that are sufficient to prevent old-age poverty” as well as “reliable means to smooth lifetime consumption for the vast majority of the population” (Holzmann & Hinz, 2006).

I light of this broader scope of consideration, it becomes a lot harder to design and implement a pension reform that adequately reflects the objectives of a pension system. According to a report published by the European Commission (2003), in order to contain the pressures on public finances, governments should undertake ambitious reforms with the objective of ensuring a fair intergenerational balance. By accepting that there is a need to curb expenditure in order to improve the financial sustainability of the pension system, policymakers are initially faced with the difficult question of allocating the cuts. Right off the bat, there are two possible ways to cut pension costs: first there is the possibility of increase the contribution rate of current workers in order to increase available budget for pensions; and second, bring down the average pension amount. Ultimately, this decision represents the choice of which generation should bear the burden of the pension system. If policymakers opt by increasing contribution rates, the burden is placed on the working population, which is forced to contribute with a higher percentage of their income. On the other hand, if policymakers decide to lower the average level of pensions, the burden is shifted to pensioners, which in turn had already contributed their entire lives at a rate that was supposed to provide them a higher pension amount. As explained by Bosworth and Burtless (2004), the choice between increasing taxes or cutting benefits represents, in essence, a zero-sum conflict where the benefit or taxes of one generation must be sacrificed in order to maintain the income of another.

In line with this concern, the World Bank report previously mentioned offered a controversial solution when faced with the issue of where to allocate the intergenerational burden associated DB-PAYG schemes when faced with sustainability issues. In their analysis, the report concludes that it is impossible to achieve intergenerational fairness under a DB-PAYG scheme. Instead, governments should opt to replace their systems in favour a multi-pillar scheme combining a Defined Contribution (DC) system with a social safety net. This conclusion rests on the argument that, under the veil of

population ageing, public pension systems, if left unreformed, are always unfair to the successive generation. Overall, the DC system suggested actually provides an option that is more actuarially fair since it tightens the link between pensions and contributions. However, not everyone is an advocate for actuarial fairness. According to Ginn (2005), increasing actuarial fairness by tightening the link between contributions and benefits, can actually re-inforce redistribution issues and increase discrepancies. The author argues that, even if some countries pension scheme has a poverty relief pillar, a means tested social assistance pension is no substitute for the "dignity" and security of an unconditional pension, which inherently puts the concept of actuarial fairness at odds with social justice.

1.1.4. Pension reform: Parametric or Systemic?

The final decades of the twentieth century were marked by a surge of pension reforms. The primary reason for these reforms has mostly been to address the financial imbalances that have risen as a consequence of population aging (Hering, 2006). Additionally, Börsch-Supan (2003) argues that the European economies face two deeply rooted macroeconomic problems that may contribute to a financial imbalance of the pension system: high levels of unemployment and slow economic growth. Consequently, the need to adapt to these realities becomes paramount in the quest for the sustainability of the Pension Systems. It is important to note that in this sense, sustainability is being considered in its broader sense, considering adequacy and poverty alongside financial sustainability.

During the 1990s, nearly all countries in the old EU-15 enacted marginal adjustments that focused on either refinancing or retrenchment of their pension systems. Moreover, countries adjusted the parameters[6] of their pension systems in order to improve the sustainability of the pension system (Hering, 2006). In spite of the adjustments that took place since the 1990s, according to the Eurofond[7],

[6] Some of these reforms may take the form of changes in statutory retirement age for example are often referred to as parametric reforms. These kind of reforms are aimed at maintaining the overall basic structure of the system while changing its parameters in an attempt to improve its sustainability.

[7] Eurofound is the EU Agency for the improvement of living and working conditions

in 2015, there were at least two reforms underway in Estonia and Greece, and five proposals for new reforms in Belgium, Bulgaria, Croatia and the United Kingdom. Again, parametric reforms appear to be the preferred pathway to re-establishing the balance of the pension system.

Although there appears to be a general consensus among policymakers in the EU in favour of parametric reforms, there have been some exceptions. For instance, in Sweden, in 1992, the Pension working group developed the blueprints to the Notional Defined Contribution (NDC) pension system that was to be implemented in 1993. Additionally, in Italy, in 1995, the Dini Pension Reform transformed the traditional DB-PAYG system into a NDC pension system (Brugiavini & Peracchi, 2007). Indeed, the most innovative reforms took place in countries such as Sweden, Italy, Latvia and Poland. In these countries, policymakers opted by a structural[8] change by revising both the objectives and the very design of old-age pension schemes. In order to achieve a more sustainable and politically feasible pension system.

The NDC pension scheme first came into the spotlight in 1994. During this year, Sweden passed a legislation that replaced its DB-PAYG system with a NDC pension system. The overall guiding principle for the adoption of a structural approach to pension reform is that which had guided Swedish public policy for since the 1950s: the adoption of an adequate earnings-related system that provided universal coverage for any individual working in Sweden, backed by a safety-net that guarantees an adequate level of income of the elderly (Palmer, 2000). Other countries like Italy and Poland were quick to follow Sweden, and did not take long after that to adopt an NDC system.

In essence, NDC pension schemes are very similar to DB-PAYG. They both operate under a Pay-as-you-go framework, where current contributions are used to cover current expenditure with old age pensions. However, they introduce notional accounts. Every year, the notional value of the contributions made is credited in an individual notional account that receives an accrual rate. Since

[8] Structural reforms radically transform a pension system by replacing totally or partially by a new type of system.

the accounts hold no real capital they cannot be used to purchase an annuity in the private market or to be converted into a lump sum at the age of retirement. Instead, once an individual retires, the notional value of their account is converted into an annuity, which takes cohort longevity into consideration. As a result, NDC systems provide a closer link between contributions and pension benefits.

There have been several arguments in favour of NDC pension reforms. First, there is the concept of 'fairness' (Brooks & Weaver, 2006). In most countries, the traditional DB-PAYG formula considers the final wages in a person's career in order to calculate their pension. As a result, it inherently redistributes income to high-income workers with higher earnings profiles. NDC schemes eliminate this problem by fundamentally removing it from the main NDC pillar and adding a complementary pillar whose sole focus is on poverty reduction. As a result, old-age pensions are a direct product of individual contributions. The higher the amount an individual contributes, the higher his or her pension will be, implying a higher degree of fairness when compared to DB-PAYG systems. Second, the close link between individual contributions and benefits provides a great incentive for individuals to work for longer periods of time in order to be able to secure an adequate old-age pension, hence increasing individual responsibility and work effort (Brooks & Weaver, 2006). Third, NDC schemes ensure a long-term balance between pay-outs and contributions, contributing to the sustainability of the system (Brooks & Weaver, 2006). Fourth, since the rate of return is determined via wage growth or overall economic growth rather than providing a return on specific financial assets, individuals are protected to short-term fluctuations in market returns associated with Fully Funded Defined Contribution (FDC) schemes (Blake, 2011). Finally, and perhaps one of the most relevant arguments for countries that wish to transition into a DC scheme, the transition to an NDC pension system is an easier step towards moving from a DB-PAYG to an FDC system (Blake, 2011). Since NDC reforms do not require governments to finance benefits for the transition generation, NDC schemes can prove to be a very financially attractive scheme for countries that which to transition into a DC system.

Another aspect that is worth mentioning that argues for the legitimacy of the NDC schemes is the fact that it diminishes the need for government intervention. Since the parametric adjustments are made mostly automatically, governments can take a step back approach, which not only can reduce management costs but it also increases the political credibility of the system (Boeri & Galasso, 2010). Overall, NDC schemes are less prone to policy changes and political pressures often associated with PAYG schemes. Moreover, NDC pension systems appear to have an upper-hand in terms of improving financial sustainability when compared with the traditional DB-PAYG system. Additionally, when appropriately designed, proponents of the NDC system argue that it may even enhance the system in terms of fairness and possible redistribution.

As demonstrated in the previous sections, in the last few decades, the structure of the Portuguese population has changed, which led to an increase in the old-aged dependency ratio. Additionally, recent projections show that, in the long-run, we should expect an increase the likes which we have never seen before. As a consequence to population ageing, the demand for old age pensions has been increasing, while at the same time there has been a reduction of the working age population. In case this pattern persists, there is the possibility of an implicit debt resulting from the structural inability of the Portuguese pension system to deal with exogenous factors. In retrospect, the apparent lack of success with past system adjustments seems to suggest that the issue is more structural and requires a solution that goes beyond the scope of parametric reforms, such as the ones that have been enacted by the Portuguese government.

Up to this point, I have been unable to identify any contribution that provides a detailed analysis of the impact of the transition to a Notional Defined Contribution system on the financial and social sustainability of the pension system in Portugal. Consequently, this thesis humbly attempts to fill this gap in the literature in Portugal. Therefore, the question that guides this thesis is the following:

- *What would be the impact of the introduction of a Notional Defined Contribution old age Pension System on the financial and social sustainability in Portugal?*

This question will then be divided into four sub-questions that will help in the analysis. The questions are as follows:

1. Does the current Pension System in Portugal have a risk of financial instability due to exogenous factors such as demographic ageing or slow economic growth?
2. Would a transition to a Notional Defined Contribution Pension System improve the financial sustainability of the pension system?
3. What would be the impact of a transition to a Notional defined Contribution scheme on the social sustainability and the adequacy of the pension system?
4. Would a Notional Defined Contribution Scheme be better to ensure sustainability in light of exogenous factors, such as demographic ageing or slow economic growth, than the current Pension System in Portugal?

In order to answer this question, the transition to a NDC pension system similar to the one in Sweden, which has shown the best performance among the countries that have transitioned, will be simulated in a Dynamic Microsimulation Model (DYNAPOR). The primary reason behind this modelling choice is that Dynamic Microsimulation Models work with micro-units and, therefore, are optimal in simulating the impact of policy choices at the individual level. Since the objective of this work is to analyse the sustainability of the pension system in a broader sense, by taking into account adequacy, poverty and social sustainability, this type of unit is essential. In order to achieve this objective, some hypothesis will be initially set out taking into account the sub-questions that were identified. The hypothesis set out to be tested in this thesis are the following:

- H_1: The process of demographic ageing and slow economic growth do not pose any threat to the sustainability of the current Pension System in Portugal.
- H_2: A transition to a Notional Defined Contribution System would significantly improve the financial sustainability of the Pension System in Portugal.

- H_3: A transition to a Notional Defined Contribution System would worsen the adequacy and the social sustainability of the Pension System in Portugal.
- H_4: A transition to a Notional Defined Contribution System would ensure that demographic ageing and slow economic growth have no impact on the sustainability of the Pension System in Portugal.

In order to test these hypothesis, the remainder of this thesis will be organized as follows. The remainder of this chapter will describe the primary elements that compose a Notional Defined Contribution System. While most works tend to skip an account of historical developments, I believe this exercise to be necessary in the case of social protection in Portugal. As a result, Chapter 2 provides a historical perspective of the pension system in Portugal. Chapter 3 contributes to the analysis by providing a through characterization of the current system. In chapter 4, I analyse the experience of the transitions to NDC that took place in Sweden, Italy and Poland in order to be able to define the strategy that is to be used in the simulation for this thesis. In Chapter 5 consists of the methodological chapter with an in-depth description of the model developed in addition to the scenarios that will be simulated. In Chapter 6, a literature review of retirement behaviour models has been included, as well as a thorough description of the model adopted and developed in this thesis to simulate retirement behaviour. Finally, Chapter 7 presents a quantitative analysis of the results and Chapter 9 holds the discussion.

1.2. Notional Defined Contribution Pension Systems

Notional Defined Contribution (NDC) pension schemes were first introduced in Sweden in 1994 and in Italy in 1995. Basically, an NDC plan treats the PAYG system as a defined contribution (DC) plan. As a result, NDC schemes share some features on the contributory side with PAYG schemes in that current expenses are financed by current contributions. However, the link between benefits and contributions is individualized and defined by the NDC accounting mechanism (Börsch-Supan, 2003).

In essence, a generic NDC system begins like any other DC system. Individual contributions for retirement are credited in individual accounts, which accumulate pension wealth for old age. These accounts are kept by the pension system. In similarity with the PAYG scheme, current contributions are used to cover current expenses. Hence, there is no real accumulation of capital. The balance in the individual account has a fictitious nature, which explains the "notional" side of the scheme.

The balance in the individual accounts earns interest at some rate of return. The rate of return is the central parameter in an NDC scheme. Since all accounts are merely notional and no capital is accumulated, the rate of return cannot be defined by market mechanisms. As opposed to a Funded Defined Contribution (FDC) scheme, the accumulated balance is not invested in financial market instruments. According to Palmer (2006), it can be argued that the terms 'financial' and 'non-financial' are a more accurate distinction between FDC and NDC respectively, as a way of stressing the fact that in FDC accounts the money is invested in market assets, while in the NDC scheme it is not.

Before diving into all the workings of the NDC scheme, it is important to further differentiate the NDC from the FDC, seeing that both these schemes have a DC nature. According to Konberg, Palmer and Sundén (2006) there are two aspects that are important to consider when differentiating the NDC from the FDC. First, the two schemes are different in their potential for national savings. In this regard, the most important aspect is whether reserve funds have collateral and what claims represent this collateral. Since NDC funds are 'notional', which means that there is no real accumulation of capital, the only collateral that exists is the claim on future contributions from workers. This means that NDC collateral is not backed by any financial mechanisms and therefore do not contribute to national savings. On the other hand, FDC plans actually offer real capital accumulation in the form of commercial bonds or stocks. Since NDC plans do not accumulate savings in real assets and are deprived of the national savings benefit that are associated with these types of assets (Börsch-Supan, 2003).

The second aspect to consider when differentiating NDC from FDC plans is the way the system's rate of return is defined. While in FDC plans the rate of return is determined by the financial market rate of return, in the NDC scheme there is an internal rate of return that is determined by the underlying development of the economy (Palmer, 2006).

Now that the distinction between the two types of DC plans is behind us, this section will follow by defining a generic NDC system. It is important to note that the structure of NDC plans varies from country to country according to the context in which it was implemented. As such, it is impossible to define a very complex, universal NDC scheme. Instead, this section will focus on the very basic aspects of an NDC scheme that are commonly shared by most countries that have reformed their pensions and opted for a Notional Defined Contribution plan. A distinction between different types of NDC plans will be offered in the following chapters.

So, what is an NDC scheme? Basically, like it was mentioned above, individuals or their employers pay contributions into notional accounts during their working career. A striking feature of an NDC scheme is that there is no "pension age", i.e. even after individuals begin drawing part, or even all, of the pension they are entitled to, any contributions made as a result from work earnings will still be credited in their notional account with a given rate of return. The benefit is a life annuity that can be claimed at any time after the official retirement age. A rate of return based on the one registered in the accumulation phase is applied in the calculation of the life annuities. The accumulation phase here is defined by the period during which the individual was contributing to the individual account. It is important to note that, since under an NDC plan there is no "pension age", there can be an overlap between the accumulation phase and the period when the individual starts drawing a pension.

The life annuity under a NDC scheme takes a rate of return based on the rate of return used during the accumulation phase, and most importantly considers the cohort life expectancy. Since the annuity takes cohort life expectancy into account, the NDC can be considered as an actuarially fair scheme (Palmer, 2006). Another important aspect of the NDC is that it transfers the capital of the deceased to

the living beneficiaries. This helps to ensure that in spite of some individuals outliving the average life expectancy of their cohorts, the system has the necessary means to cover the additional expenses. By including the PAYG rate of return and the average duration of retirement in the calculation of the pension annuities, the NDC is linked to demographic and macroeconomic events. As such, it is automatically adjusted when faced with fluctuations in these parameters, lowering the benefits when necessary to maintain sustainability.

1.2.1. Advantages of an NDC scheme

So how does the NDC scheme fair against its counterparts, the DB-PAYG and FDC systems? As previously explained, NDC schemes differ from country to country. As a result, this analysis of the advantages of an NDC scheme will focus mostly on generic, rather than specific advantages. Although, at first glance, the NDC scheme appears to be a simple alternative way to calculate pension benefits, it actually possesses a number of positive aspects. First, NDC schemes display superiority in terms of risk management. As shown by Góra and Palmer (2004), NDC schemes are a better way to manage risks when compared to other pension arrangements. While NDC faces the same macroeconomic and, to a lesser degree, demographic problems as other schemes, it is, at least in contrast with other DB systems, much less exposed to political manipulation and not at all to opportunistic hazards. In their work, Boado-Penas and Vidal-Meliá (2013) argue that, at least theoretically, NDC schemes are stronger against political risks. Since NDC schemes adjust more or less automatically to demographic and economic fluctuations, politicians are able to implement unpopular pension cuts without the need for political decisions. As a result, this type of pension scheme has a higher degree of protection against opportunistic behaviour from politicians attempting to earn popular support. Additionally, since there is no capital accumulation, it is somewhat protected against financial market fluctuations

A second positive aspect is that NDC schemes facilitate desirable design features. Among these features, Barr (2004) identifies 3 that are noteworthy. First, NDC schemes allow for a flexible retirement age. As a result, it increases individual choice over consumption smoothing. Second, there

is a flexible combination of work and retirement, which ultimately leads to an increase in individual choice. Finally, if correctly designed, NDC schemes will automatically respond to fluctuations in the demographic and macroeconomic environment. Since benefits are indexed to longevity through the conversion of notional accounts into annuities, and fertility and employment, through the notional rate of return, NDC schemes provides an automatic adjustment mechanism that eliminates the need for arbitrary indexation rules or adjustment factors, which have ultimately undermined the credibility of conventional DB scheme.

A third positive aspect of NDC schemes is that it provides a sense of both actuarial fairness and actuarial neutrality (Simonovits, 2006). By transforming a DB system with weak incentives into an NDC scheme, a stronger link between individual contributions and pension benefits is obtained. There is an enhanced degree of fairness associated with the DC formula, especially when compared with DB schemes that base their pension benefits on the wages of the last few years, which tends to implicitly redistribute wealth towards workers with higher income profiles (Brooks & Weaver, 2006).

Fourth, supporters of NDC arrangements argue that by tightening the link between benefits and contributions means that individuals that work for longer periods of time will, in turn, be entitled to higher pensions. This aspect improves not only the systems' financing but also fosters individual responsibility and work effort. Finally, NDC schemes provide a feasible and cheaper alternative to the costly transition to FDC scheme (Brooks & Weaver, 2006).

1.2.2. Disadvantages of an NDC scheme

Despite the many advantages enunciated, there are also some disadvantages associated with NDC arrangements. The first, and perhaps the most important for this work, is that NDC schemes are considered sub-optimal in welfare terms. As we have previously explored, pension systems have several objectives: consumption smoothing, poverty relief and distributional objectives. While a strict adherence to actuarially sound benefits may provide consumption smoothing, it is far weaker in terms of poverty relief and distribution. Ultimately, in comparison to DB schemes, NDC arrangements offer

a trade-off between an increase in the political and financial sustainability of the pension system at the expense of poverty relief and distributional objectives. NDC supporters argue that these shortcomings can be overcome by the introduction of an extra pillar, or even programs, aimed at poverty relief. Second, while transparency is an advantage of NDC, it can also become a shortcoming. At any given point in time, an individual may calculate his or her pension. This means that there is a general individual knowledge with regards to the financial situation of the pension system that may easily translate into a personal concern, undermining confidence in the system as a whole (Brooks & Weaver, 2006).

1.3. Conclusion

Pension schemes have several objectives, ranging from consumption smoothing to redistribution and poverty relief. However, as shown in this chapter, recent developments, such as population ageing and economic instability have not only undermined the ability of governments to meet these objectives, but also questioned the very sustainability of pension arrangements all over the world.

In light of these issues, there is a general consensus that pension schemes need to adapt to the changes of the context where they operate in order to properly insure its beneficiaries and guarantee its sustainability. Under this idea, there has been a growing number of countries in the European Union (Italy, Sweden and Poland for example) that have undertaken NDC pension reforms to their pension system in an attempt to improve it. NDC schemes offer conceptual elegance and the promise of fiscal discipline that is seen to be lacking in more traditional DB PAYG pension plans. It is a politically appealing policy since it combines a sense of fairness, as a result from closely linking contributions to benefits, along with the promise that there will be no need to employ politically unappealing policies such as benefit cutbacks for example. Since the scheme mostly runs on an automatic principle of adjustment, it is likely to remain popular among blame-avoidance politicians.

Overall, the analysis in this chapter suggests that there are important pros and cons associated with a transition to an NDC scheme from a traditional DB PAYG. First, NDC schemes are superior in terms of

financial sustainability. However, NDC seems to lack behind in terms of poverty reduction in comparison to their DB counterpart. It is clear to see that there is a trade-off between financial sustainability and poverty alleviation associated with a transition from a DB to an NDC scheme.

Under the umbrella of this issue, this thesis aims to contribute to the literature on pension reform in Portugal. The main question that guides this work is: in the eventuality of a transition in towards an NDC scheme what would be the impact on the financial and social sustainability of the pension system in Portugal? Additionally, this thesis aims to shed some light on what would be the transition costs associated with this transition? Ultimately, this work aims fill the gap of literature on the viability of a transition to NDC in Portugal.

Chapter 2: An Historical Perspective of the Pension System in Portugal

While most works tend to skip an account of historical developments, I believe this exercise to be necessary in the case of social protection in Portugal. In order to understand how the system has reached its maturity we must shed some light on the historical context in which it was developed. When analysing the question of policy change, it is important mention the work of Pierson (2000) and his theory of path dependency. According to this model, institutions and policies are sticky and once a government has gone down a path, it becomes costly and very difficult to reverse it. As Pierson (2000) notes, public policies and institutions are often difficult to change, therefore, past policies influence new policies by encouraging policy continuity. Therefore, in order to understand the current situation of the Pension System in Portugal, it is imperative to have an understanding of its origins and how it was restructured over the years. Consequently, this chapter will cover the development of the Social Security system in Portugal, from the birth of the nation to the system that is currently in place.

2.1. Traditional Sources of Security in Portugal

Unemployment, illness and old age are not sole characteristics of contemporary times. If we take a look at historical works we can see that uncertainty was a significant aspect of life. Fortunately, in more developed and mature countries we have devised a system that attempts to insure us against these almost inevitable conditions. However, this has not always been the case. Since the victory in Ourique in 1139 – commonly assumed as the birth of Portugal as a kingdom – to the Discovery Era, social protection existed merely as random acts of kindness. Feudal relationships governed the land and kings conceded land to nobles that in turn employed peasants or serfs. While life under the control of a feudal lord could be bleak and hard at times, it offered a certain degree of stability that could be considered a great luxury in such a violent and dangerous era. At the same time as feudalism, institutions financed by kings, nobles and the clergy began to appear that tried to cater to those in need. These institutions, known as *Albergarias* and *Hospitais,* were often connected to associations of

pious laymen or *confrarias* and served as houses for the indigenous poor and the marginalized (Disney, 2009). However, tensions between religious orders and wars meant that the scarce resources available were poorly coordinated leading to ineffective and erratic social assistance.

With the arrival of the Discovery Era, the already bleak social protection situation worsened. The number of orphans and widows began to increase dramatically as men ventured into uncharted seas and territories. As a response to the growing social unrest, the first social protection institution was created in Portugal in 1498. *Misericórdia* – mercy in Portuguese – was an institution sanctioned by the clergy and the Portuguese crown that provided assistance to those in need. Additionally, it managed most of the hospitals in the country and provided financial assistance – although very limited – to farmers. With the support from King Manuel, Misericórdia managed to spread its influence throughout the Portuguese land, reaching an astonishing 120 branches by 1625 becoming one of the most widespread and influential social institutions in Portugal.

2.2. The 19th Century and the Industrial Revolution

The 19th century was a time of social, economic and political change not only for Portugal but also for most of the developed world. The efforts of Thomas Newcommer associated with major developments by mechanical engineer James Watt developed the engine that would power the industrial revolution throughout the 19th century. While countries such as Brittan and France embraced the industrial revolution during the early stages, eastern and southern European countries, which displayed a more rural setting during that period, were late joiners.

While the "steam machine" worked its way through Europe, economic transformation took place. Populations started to grow at an unprecedented rate, extending well into the 19th century itself. The Portuguese population, for example, increased a staggering 75% during the 19th century (Veiga, 2004). Although this increase was not as significant as what was experienced in other countries in Europe, a population growth of this magnitude brings with it several changes in the social, political and economic workings of a nation. Additionally, the very nature of work changed becoming increasingly impersonal.

Indeed, the changes in the means of production had severe consequences on the way the labour market worked. Individuals started to move to urban areas where factories were built, trading their skilled jobs for factory floors. They were taught factory skills that allowed them to perform repetitive jobs for long hours a day. Aside from poor working conditions, living arrangements were also poor. People were moving away from poor living conditions in rural areas only to find the same kind of arrangement in urban areas.

From a social protection point of view, the Industrial Revolution brought about changes that opened new gaps on an already porous system. At the beginning of the 19th century and with the start of industrialization in Portugal, the Misericóridas, that had been the cornerstone of social protection until that time, were unprepared to meet the needs of the new industrialized context. Workers were increasingly unhappy due to poor working conditions and lack of social protection, giving rise to protests and a general discontent among the working population. This led to the creation of mutual aid associations (*associações de socorros mutúos)*. These associations consisted of a non-profit private system of social protection that envisioned the mutual support of individuals in order to improve and solve precarious situations (Costa, 1986). According to Pereira (1981), the industrial revolution destroyed most of the informal mechanisms of social protection that were put in place up to this time. Before these associations were put in place, social protection needs were met based on voluntary support of fellow workers, neighbours or family members. In several occasions this was the only means of support of the growing number of workers. Further, due to its voluntary nature, this type of aid was mostly uncertain and could very easily fail to cover those in need. Instead, the founding of associations aimed at trading the uncertain nature of aid for the certainty of an associative care as a means of security against workers risks and insecurities emerged (J. Pereira, 1981).

In many areas, mutual aid associations were pioneers in the provision of care in Portugal. They created conditions for individuals and their families to access education and health services and gave them the ability to ensure themselves against possible future needs, such as illness, disability or even

unemployment. The mutualist network that developed in Portugal in following years was noteworthy. The number of associations rose from 295 in 1883 to 628 in 1909 (Halpem, 1999). While the growing number of mutual aid associations attempted to provide social protection in many fronts, their scope was limited mainly to aid in the event of illness. It is important to consider that these mutual aid associations emerged in order to target a problematic area of the working population. They were created mainly by workers and did not benefit from any kind of legislation support during their development. The fact that most of their beneficiaries received low wages when associated to the voluntary nature of these programs greatly influenced their ability to finance such endeavours. Additionally, employers were not contributing to these programs, which meant they were financed solely by workers. Mutualist associations came in short especially in the realm of pension provision. The lack of available information between contributions and expenses associated with their limited knowledge about mortality and life expectancy created the conditions for the downfall of most of these programs.

Most evidence of the performance, victories and shortcomings of mutual aid associations comes in the form of the works of Goodolphim (1889), one of the authors that most explored the work of these associations in Portugal. Despite a generally positive view, Goodolphim is quick to realize the shortcomings of mutual aid associations and the need for the involvement of the State in welfare provision. The lack of a compulsory character of mutual aid associations associated with their poor organizational skills and lack of technical resources makes a compelling argument for the intervention of the state, going beyond associative management and optimizing the provision of social protection advertised by these associations.

2.3. The First Republic

When the First Republic was proclaimed in Portugal, the role of the state in social affairs was still very limited. As seen, most of social protection was left to the care of ineffective associations that lacked both the means and the legislative support to provide adequate aid to those in need, but with the

implementation of the First Republic in 1910 also came the growing involvement of the state in social affairs. The inclusion of the Portuguese State in welfare provision was not a simple task to achieve. It was through the persistent work of Estevão Vasconcelos, a medical doctor elected by the Republican Party in 1908 and by the '*Assembleia Nacional Constituínte'* (ANC) in 1911, that the 'first' measures of welfare were approved and sanctioned by the state.

The approval of the law against work hazards (*'Lei de Acidentes no Trabalho*) was the climactic point in Vasconcelo's career as an elected member of the ANC. This bill consisted of a system of protection for workers covering not only work related accidents – such as illness or even death – but also illness, unemployment and old age. The program was to be financed via contributions of employers, which would contribute 50% of the value of the premium, while workers would contribute 10% and finally the state would match 40% of the contributions. Despite the obvious coverage and extension of this program when compared to the problematic assistance provided by mutual aid associations, it was not an easy bill to pass in congress. Vasconcelos had been presenting this bill since before the Monarchy was overthrown and failed up to this time. Further the bill was not passed in several sessions already in the time of the First Republic. So what had changed? What made this bill so appealing all of a sudden? Well, there was a long debate that dragged through the years on the need for the involvement of the State in social protection, with special focus on work hazards. While mutual aid associations opposed the involvement of the state as a regulatory partner, others saw it as an important contribution to the evolution of welfare provision in Portugal and especially as a convergence with many of the European countries.

The work of José Francisco Grilo is noteworthy in the case for government intervention. Grilo was a journalist for the newspaper "O Século" that contributed extensively with writings on the debate that was taking place. With a focus on mutual aid relationships of workers and rural proprietors, Grilo argued for the existence of a mutual support that was free from the involvement of the state. However, in symmetry to the works of Costa Goodolphim (1889) mentioned earlier, Grilo recognizes

that Portugal was still devoid of any kind of legislative support to mutual aid associations resulting in a coverage and fiscal sustainability problem for mutual aid associations (D. O. R. Pereira, 2012). By framing out of the Portuguese context and looking at Europe, it was easy to see that this path was widely accepted. Vasconcelo's proposal was actually based on legislation already implemented in most of the states leading welfare at the time, such as, the Great Britain, Germany, Finland, etc. which had already accepted a more active role from the state in the provision of welfare.

Another author that wrote extensively on the role of the State in playing a more active role in the provision of healthcare, be it in a financial or regulatory manner, was Lobo d'Avila Lima. In the first part of his book entitled "Mutual aid and Social Insurance" (1909), Lima analyzes the various types of mutualist associations around Europe. He follows with an analysis of a compulsory insurance system and its applicability in the case of Portugal. Lima concludes that the best course of action is not an extreme stance where there is only one system in place, but a conciliation of both systems where the intervention of the State as a regulatory presence should not limit any advances in the private, or associative, provision. Finally, after several attempts and changes to the original proposal made by Estevão Vasconcelos, in 1913 the bill was passed. Portugal had finally joined the other countries in the development of their first system of social provision with the participation, although limited, of the State.

Following the approval of the bill, in 1916 the Ministry of Work is created. It was a difficult time. Not only were social tensions with the working population were on the rise but the First World War was underway. The need for stabilizing measures led to a more active position from the State in the matters of welfare. In 1919, a compulsory social security bill was passed and with it, a new institution was created with the aim to regulate and administrate it, the Institute for Compulsory Social Insurance and Social Provision (ISSOPG in Portuguese).

2.4. The 1940s-1960s: a period marked by reform and a re-orientation of social protection

Up this point, the Portuguese system of social protection had been developing at consistent speed. From an initial period of a simple and rudimentary system to an increasingly intrinsic system, consisting of several sector-based funds supported by the establishment of family support funds in an attempt to cover the whole country. Another aspect that added to the complexity of the system was the type of assistant provided, which varied from fund to fund (Guibentif, 1996). The complex nature of the system associated with serious problems in the realm of fund management gave place to a serious attempt at an attempt by the Portuguese administration to try and rationalize the system the best way they could.

In sum, Guibentif (1996) identifies five measures upheld by the Portuguese government. First, between 1946 and 1965, there was a systematic effort of creating and strengthening central agencies that focused on the administration of funds (Central Social Security Fund for Migrant Workers, Social Benefit Fund Federation and National Workplace Sickness Insurance Fund are an example), which led to the creation of the National Pensions Fund. Second, in order to mitigate the complexity of the system, an attempt was made at harmonizing the rules that governed funds. Through law No. 2115 of 1962, institutions were to follow the regulation drafted in their service provision. This regulation became later referred to as "*Regime Geral*" (general scheme). Third, in the early 1960s, Portugal managed to achieve nationwide coverage by setting up district funds where one did not exist yet. Fourth, and possibly the most important change that took place during this period, in the context of the new "*Regime Geral*" fund management was to become the responsibility of district funds, which were mainly responsible for short-term benefits, and the newly formed National Pension Fund, which was set up in 1965 and dealt with the long-term benefits. This reform adopted a mixed funding method of capitalization and PAYG. Finally, the last significant measure was the transfer of the health assistance sector from the Ministry of Health to a newly formed Ministry of Corporations and Social

Security. This move was a consequence of the problematic link between the sector of *previdência social* and the health assistance sector. Because the *caixas sindicais de previdência* were involved in the health assistance sector, there was a need to better coordinate both sectors in order to optimize their functions.

2.5. The Revolution of 1974: a time for Democracy

As history tells it, Marcelo's government was to be short-lived and on Thursday, 25th of April of 1974 Portugal was to experience the collapse of dictatorship rule under a bloodless military coup. It is easy to perceive that a military coup would have extensive implications in terms of social provision. The very nature of the revolution was to have a great influence in shaping social policy to come. It is important to take into consideration that the revolution aimed at overthrowing the dictatorship rises from an era characterized by colonial wars and a deteriorating social situation. As such, the new government, in the hopes of consolidating their legitimacy adopted a series of measures in the field of social affairs. Three main measures can be identified that characterize the early reforms of social provision in old-age during the early years of the new regime (1974-1977).

First, it is still in 1974 that the new democratic regime makes its first move in terms of social protection in old-age. The iconic creation of the *Pensão Social* (social pension) sought to cover every individual aged 65 and over that was not covered at the time and were supported only through social assistance. This measure is a clear step away from the Bismarckian inspiration of the previous regime towards a more universal coverage. The idea that the only ones that should be entitled to a pension were those that contributed to the system was being slowly dissolved into the new system. The social pension was later to be extended to those that did not possess an income. Another measure implemented in these early days was the concept of early retirement. The new government recognized that different activities have different impacts from a physical and psychological point of view and therefore require different rules when it comes to retirement age. Those that mostly benefited from the introduction of early retirement were individuals that worked in physically intense jobs, such as fisherman or miners

for example. Finally, due to an increase in the cost of living during the last years of the New State, pension amounts were updated so that the purchasing power of pensioners.

As one might expect, these three early measures represented a significant increase on the number of beneficiaries of old-age pensions in Portugal. In the 10 years following the revolution, Portugal saw a significant increase in their pension expenses that was hardly accompanied by an increase in contributions. Had it continued in this path, the current over-spending system was doomed to fail. There was a clear need for structure and management of social security. As such, financial management of social security was delivered to the *Instituto de Gestão Financeira da Segurança Social.*

The period between 1974 and 1990 can be considered a time of stabilization for social security in Portugal. Aside from the early measures implemented there was little activity. Guibentif (1996) identifies three main aspects that contributed to this time of inactivity. First, there was a clear financial problem. The current government had to deal with the expansionary promises made in social provision by the previous regime that had clearly put the country in a fiscal knot in a post-revolution time where public finances were still being put in order. Second, relates to Portugal's membership to the European Community that was a strong incentive to keeping the system unchanged. The third and final aspect was political stability. Since 1985 to 1995 Portugal was governed by Social Democratic party, which won absolute majority with the social security system of the time. As such, the Social Democratic party sought to tread lightly in the reform realm so not to jeopardize its position.

Although it was a slow time for pension reform it was not a completely stale period. It is in 1984 that the Lei de Bases da Segurança Social (LBSS) is drafted and accepted in Parlament. This Law sought to cover the active population and their respective families in the eventuality of inability or the reduction of the capacity to work, unemployment, death and those families in precarious economic conditions. With regards to the financing of Social Security, in order to ensure the sustainability of the system, this law determined that Social Security was to be financed through contributions from its

beneficiaries, their employers and transfers from the State budget, where the latter was to be responsible for the financing of the entire non-contributory regime.

In terms of pension arrangements, the formula for the determination of the pension value was kept unaltered from the one established by the Decree nº 9/83. In this document, the value of an old age pension was determined by the product of 2.2%, reference earnings and the number of years with contributions. In this case, reference earnings was calculated as the average of the best 5 of the last 10 years of earnings. According to this formula, the resulting old age pension was limited between 30 and 80 percent of reference earnings. This formula lasted for the following 9 years, however, in 1993 the situation became unsustainable and some adjustments had to be made. The arguments that were present in the in the claims for problems in the sustainability of the pension system will be discussed ahead when Law nº 329/93 of the 25th of September is discussed.

From the beginning of the 90s, Social Security saw a number of transformations that would culminate in what it is today. In 1990 there is the introduction of the 14th month for pensioners. The year 1993 saw the reformulation the disability and old age pensions in the general scheme by introducing equality in the age for access to old age pension for both sexes, an increase the minimum amount of contributory career to 15 years and an alteration of the formula for the calculation of the pension amount by considering the best 10 of the last 15 years with the objective that the pension amount would better reflect the earnings of the individual at the end of his/her career. Still in 1993 the social complement was introduced for individuals without the necessary contributory career. In 1996 the minimum guaranteed income was introduced as a benefit of the non-contributory regime.

The year of 1993 was the stage for a very important reform of Social Security. The expansionary nature of previous reforms, due to the growing poverty and social exclusion, was finally beginning to take shape in the form of an increase of the deficit. This environment of growing expenditure shaped the following Decrees that were published with the intent to improve the sustainability of the scheme. Among these, one Decree stands out due to the magnitude of the changes that brought about, Decree

nº 329 of 1993. This decree was the first to distinguish between solidarity and the insurance components in terms of financing. However, it goes far beyond. Changes in the demographic, economic and social environment were creating tightening pressures for the sustainability of Social Security as it was. The progressive ageing of the population, which resulted from a decline in the number of births and the increase in longevity, led to the expansion of the number of pensioners. This has significant impacts for the sustainability of the scheme, especially taking into account that expenses with pensions already represented the biggest expense in terms of resources. The retrenching nature of this decree was an important step in adjusting the scheme to the new and continuously changing socio-economic and demographic environment it was supposed to protect. In light of these issues, the main changes brought about by the Decree 329/1993 were the following:

- A cut of 0.2% in the accumulation tax for pensions, which decreased the overall value of new pensions.
- An increase of 5 years in the prazo de garantia in both old age and disability pensions, resulting in 15 and 10 years respectively.
- The standardization of the statutory age of retirement between men and women at 65 years old (an increase from the previous 60 years old for women).
- Changes to the formula used to calculate the reference earnings, from the average of the best 5 of the last 10 years to the average of the best 10 of the last 15 years.
- Development of the Social Security scheme for independent workers.
- The introduction of a basic social complement, with no contributory basis, to be attributed to individuals with earnings below the minimum pension value.

A final Decree worth mentioning that was published before the Segunda Lei de Bases da Segurança Social was Decree nº 9/99. This decree aimed at defining the rules of eligibility for early retirement.

2.6. The new millennium

Resulting from the paradigm of insufficient social protection associated with fiscal pressures and the overall long-term sustainability of Social Security, the beginning of the new millennium was characterized by the arrival of the Segunda Lei de Bases da Segurança Social (SLBSS). The publication of the Decree nº 17/2000 aimed to improve the overall levels of protection, with primary focus on those in need as a means of positive differentiation; guarantee the financial sustainability of the public scheme of Social Security; and to promote the efficacy and the efficiency of the system (MTSS, 2002). Under the umbrella of this law, the general scheme of Social Security became divided by three sub-systems as follows:

- System of citizens social protection, aimed at promoting the well-being and social cohesion by the attribution of a minimum guaranteed income, pensions and other social complements.
- System of family social protection, aimed at compensating for family care costs.
- System of welfare, aimed at compensating for the loss of income due to death, illness, unemployment, old age, disability, work accidents or professional illnesses.

In order to ensure the goals set out by the SLBSS, there were two major policy objectives that guided the following decrees. These were changes to the financing regime of Social Security and changes to the formula used to calculate the value of old age and disability pensions. With regards to the financing of Social Security, the SLBSS attempted to adjust the sources of financing according to the specific social protection programs they were intended to as a means to unequivocally determine of the financial resources necessary. One year later, Decree nº 331/2001 deals with the selective adequacy of the sources of financing (MTSS, 2002). During this time, the Social Security regime began to encompass three different types of financing according to the specific nature of the programs. These financing types were as follows:

- Tripartite (Three way financing), referring to contributions from employees, employers and government transfers aimed to finance the family protection subsystem;

- Bipartite (Two way financing), referring to contributions from both employees and their respective employers aimed to finance the welfare subsystem;
- Solely finance through government transfers aimed to finance the subsystem of social protection of citizens.

In terms of the pension formula, Decree nº 35/2002 established a new formula the calculation of the pension amounts of the General Scheme of Social Security (GSSS) that differed from the previous formula in two fundamental points. First, the reference earnings were no longer calculated using the best 10 of the last 15 years. Instead, they now covered the entire contributory career of the individual. For the cases of individuals with a contributory career above 40 years, the formula will count the best 40 years of the total amount of years. Second, it established different accrual rates indexed to the earnings brackets of the individual. According to a study by the Regulation Committee of the LBSS, the restructuring brought about by Decrees 35/2002, 331/2001 and the newly established LBSS aims to redistribute the responsibility for the financing of Social Security by shortening the gap between contributions and expenses, ensuring, in this way, the long term sustainability of the pension system and reducing the expected fiscal pressures of the next 50 years, ensuring at least a fiscally loose period of at least 30 years (MTSS, 2002). Despite the optimistic view expressed by the Committee, the adjustments made were not sufficient to ensure the sustainability of the system and in October of 2006 the government and its social partners agreed upon a new Social Security Reform. This reform took shape in the beginning of 2007 as a new Framework Law for Social Security by Decrees nº 4/2007 and 87/2007 as well as the transposition of reform measures to the CGA. The main changes implemented under this reform will not be systematically reviewed.

2.6.1. The anticipation of the new pension formula established in 2002

As previously explained, Decree nº 35/2002 set out a new formula for establishing the value of Social Security pension that differs from its predecessor in two fundamental ways: first it takes the whole contributory career to calculate the reference earnings and second, it sets out different accrual rates

according to individual earnings that are indexed to the value of the IAS, benefiting lower rather than higher earnings.

However, the 2002 Decree also established a transition period that was to be applied. During this period, the pension value was determined by the highest value between the new regime and the weighted average of the pension from the previous regime and the new regime where the weights were calculated by the number of service years before 2001 (Cunha, Paulo, Sousa Pereira, & Reis, 2009). At first, the transition to the new formula was supposed to come into play only in 2017, however, in 2006 it was decided to bring the release date forward and it was brought forward to 2007. It is important to take into account that there were transition clauses that regulated the formulas to be used to calculate the pension value. Among these three different situations were contemplated in these clauses. The first refers to individuals that were registered in Social Security before 2001 and that will retire before 2016. For these individuals, the value of their pension is calculated by a temporary benefit formula that contemplates their service years before and after 2007 (the year of implementation):

$$Pension = \frac{P_1 \times C_1 + P_2 \times C_2}{C}$$

Where P1 refers to the reference earnings calculated using the old formula (the best 10 out of the last 15 years; P2 refers to the reference earnings calculated using the new formula (using the full career length); C refers to the full career length; C1 refers to the career length up to the 31st of December of 2006; and C2 refers to the registered career length after 2007. This formula takes into account an average of both the new and the old formulas used to calculate the pension value.

The second situation contemplated in the clauses is for all individuals that were registered in Social Security before 2001 but are supposed to retire after 2016. For these individuals, the pension value will be defined by a weighted average of the new and old formula, very much in the same way as the

previous formula, however, this formula will have reference to the career length before and after the 31st of December of 2001.

Finally, for those individuals registered after 2002, the full career length is used to determine the pension value up to a limit of 40 years. As previously explained, for career lengths that exceed 40 years, the best 40 years are used to calculate reference earnings.

2.6.2. The introduction of a sustainability factor that links the value of pensions to life expectancy at 65 years old

In an attempt to mitigate the fiscal pressures that pension systems suffer due to increases in life expectancy, a sustainability factor was introduced. The sustainability factor introduced during this reform is given by the ratio between life expectancy at 65 years old in 2006 and the life expectancy at 65 at the year of retirement (Cunha et al., 2009). This new measure was introduced in all pensions after 2008 and is given by the following formula:

$$Pension_t \times \frac{LE_{2006}}{LE_{t-1}}$$

Where LE stands for Life Expectancy at the age of 65 published annually by INE and t is the year the pension was requested. The introduction of the sustainability factor represented in the equation leaves beneficiaries stranded with a decision to make: either they accept the penalties associated with the sustainability factor and retire at the statutory retirement age, or they postpone their retirement until they manage to offset the effects of this measure.

2.6.3. The definition of a rule for pension updates

The new rule for pension updates links the annual increase in pension values to both Consumer Price Index (CPI) and Gross Domestic Product (GDP), which are responsible for changes in the Social Security revenue pattern. Following the indexation of pension updates to CPI and GDP, the annual increase of all pension types is now given by the following table 1. Additionally, Decree nº 53/2006 replaced the Minimum Guaranteed Monthly Earnings by the Social Support Index (*Indexante de Apoios Sociais* –

IAS) as a new reference for the calculation and the update of government sanctioned benefits. As such, there were rules established for updating the IAS, which in turn update the value of other pensions and benefits attributed by Social Security. This way, the National Minimum Wage (NMW) remains a relevant instrument of Labour Market Policy.

Table 1 Rules for pension updates

Pension Value	**GDP real variation rate under 2%**	**GDP real variation rate between 2% and 3%**	**GDP real variation rate equal or above 3 %**
Pensions under 1.5 x IAS	CPI change rate	CPI change rate + 20% GDP real variation rate (minimum : CPI change rate + 0.5 pct	CPI change rate + 20% GDP real variation rate
Pensions from 1.5 to 6 x IAS	CPI change rate - 0.5 pct	CPI Change rate	CPI change rate + 12.5% GDP real variation rate
Pensions from 6 to 12 x IAS	CPI change rate - 0.75 pct	CPI change rate - 0.25 pct	CPI change rate
Pensions above 12 x IAS	no update	no update	no update

Source: Ministério do Trabalho, da Segurança e da Solidariedade Social (MTSSS)

In order to determine the reference GDP growth rate, it was determined that the in the year of implementation (2008) the reference GDP growth rate should be that of that year. Additionally, for any subsequent year, the GDP growth rate was determined by the average growth rate of the previous two years. According to the CPI, the change rate to be used is the one available for the previous 12 months that is available in November (Cunha, Paulo, Pereira, & Reis, 2012). Additionally, the

legislation foresees that this rule for updating pensions should be reassessed every couple of years in order to ensure its adequacy in terms of fiscal sustainability and pension value.

2.6.4. The introduction of more severe penalties for early retirement and bonuses for postponing retirement in an attempt to foster later retirement

Finally, the last noteworthy measure consisted of introducing a rule that would discourage individuals from retiring early. This measure was simple enough and it consisted of a higher penalty for individuals that retired early, calculated on a monthly basis. According to this rule, for every month that an individual retired prior to the statutory retirement age, he or she would incur a penalty of 0.5 percent over, instead of the previous 4.5 percent calculated on an annual basis.

Chapter 3: Characterization of the Current Pension System

3.1. Characterization of the current Portuguese Pension System

The current pension system in Portugal is composed of two co-existing schemes: the *Caixa Geral de Aposentações* (CGA) and the General Scheme of Social Security (GSSS). The CGA ensures the civil servants against loss of income in old age, disability or surivors pensions, alongside other specific benefits (CGA, 2016) This regime is currently closed and new public employees that have entered public work after the 1st of January of 2006 are integrated in the GSSS. The GSSS is a compulsory scheme for all private employees as well as private-sector self-employed workers and covers old age pensions, disability and survivors pensions.

With some exceptions from specific pensions in the CGA, these schemes are financed in a cost-sharing arrangement between employers and employees, i.e. current contributions finance current expenses, abiding to a principle of intergenerational solidarity. Current contributors finance current beneficiaries in the expectation that when they reach old age the earlier generations will finance their pensions. In the eventuality that current contributions are insufficient to finance current beneficiaries, the remaining value is finance via transfers from the State Budget as well as other government entities or public funds in order to ensure that obligations assumed by the government are met and that pensions get paid out.

The Portuguese pension system can be defined as a defined benefit Pay-as-you-go (DB-PAYG) scheme. Currently, pension values are defined by three static factors: reference earnings calculated according to the rules in social security; accrual rate, which is defined by law; and the size of the contributory career. This means that individuals can calculate the value of their pension with a great deal of certainty, which helps managing rights and expectations at an individual level.

The current (2017) official retirement age in Portugal is now 66 years and 3 months and is predicted to increase gradually in the following years. This development follows an automatic adjustment of

updating the official retirement age by two-thirds of gains in life expectancy from the age of 65 measured as the average of the previous two years, as one of the measures introduced in the reform of 2007. According to this rule, the official retirement age can be reduced by 4 months for each year that surpasses a contributory career of 40 years when the beneficiary turns 65 years old.

In order to benefit from a retirement pension, individuals must have at least 15 years of contributions, with at least 120 days of registered earnings per year. From 2002 onwards, all earnings referring to the full career are taken into account in the determination of the reference earnings that will in turn determine the value of the pension to be attributed to the individual. There is a transition period during which the formula to be used is the one that results in the most favourable pension value for the individual. At first, the end of this transition period should only arrive in 2017, however, in 2006 it was decided that in order to ensure the long-term sustainability of the system it was necessary to bring this date forward to 2007.

3.2. Sustainability of the Portuguese Pension System: the General Scheme

Population ageing has rapidly reached the spotlight in both academic and policy circles. Currently it is a common occurrence to open up a newspaper or a magazine to find a great deal of articles on this subject, containing a wide range of discussions associated with this phenomenon. The year 2012 seemed to have been an official acknowledgement of population ageing and the challenges associated with it by many international institutions. During this year, the World Health Organization (2013) dedicated its Annual World Health day to Ageing. Additionally, the European Comission (2014) declared 2012 as the Year for Active Ageing and Solidarity between Generations. The relatively recent acknowledgement of population ageing and its challenges is a product of the fact that human ageing is, perhaps, one of the most dynamic aspects of modern demography. The impacts of this unprecedented phenomenon can go beyond the normal spectrum of demographic events and, if left alone, it may have an influence on public health and national economies all over the world. However, the world population has not yet experienced a significant increase that should provoke such drastic

concerns. According to the United Nations 2015 World Population Ageing Report, the world's elderly population has only increased from 8 to 12 percent in the past 6 decades. Hardly an increase that should culminate in such a grey doomsday scenario such as those depicted in several publications. So how do these concerns arise?

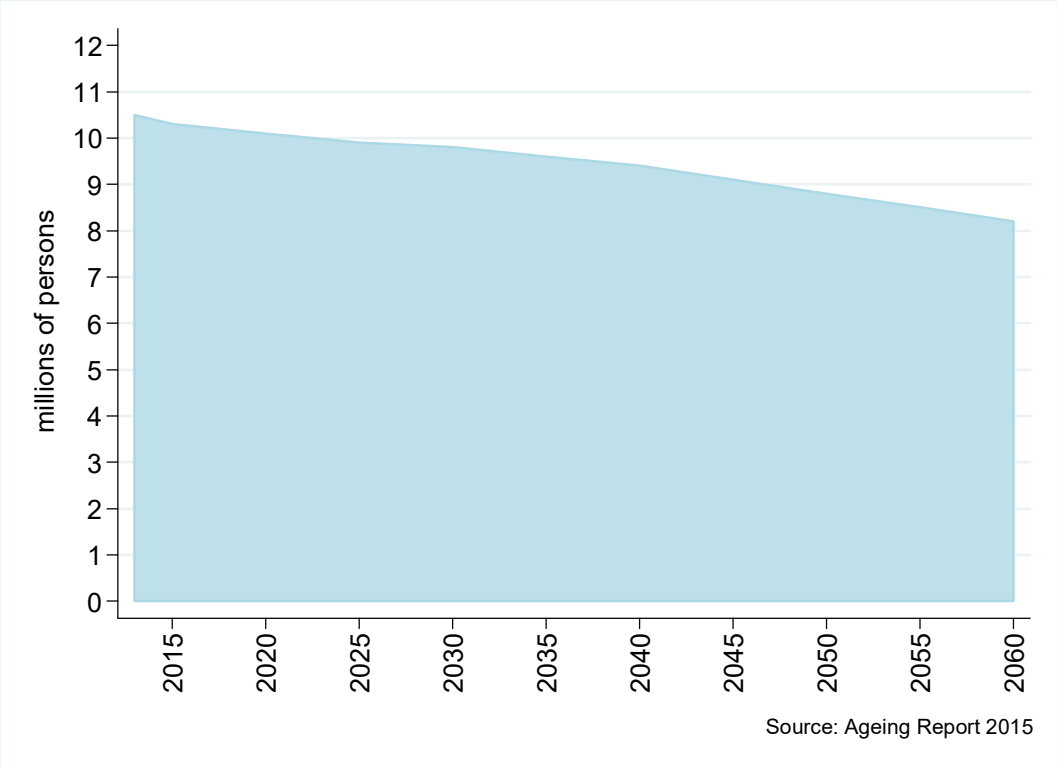
The reason for these concerns have to do with the factors that are behind population ageing. The main drivers that potentiate the phenomenon are declining fertility, increased longevity and falls in mortality. However, despite the fact that these drivers have set population ageing well on its way to continue, there is no reason to give into these doomsday scenarios. This type of "forecast" is often predicated upon a static policy context and a linear evolution of the drivers of population ageing. Under these assumptions, the resulting scenarios are often characterized by a severe shortening of the workforce, economic turmoil and, most relevant to this thesis, the untimely fall of Social Security systems. However, there is no need for concern yet. The history of humanity is one filled with tales of adaptation to new social and political contexts and perseverance in the face of the many challenges experienced. As such, ageing should not be seen as "the end of things to come", but instead as an opportunity for adaptation and improvement. In order to adapt to the aforementioned challenges brought about by the demographic phenomenon of population ageing, it is imperative to possess information on the current situation of pension arrangements, as well as reliable forecasts of the challenges and future demographic trends to come. The purpose of this section is to provide that very information by looking at reliable data and forecasts without jumping to an unfounded "doomsday" scenario. This exercise is of the utmost importance for policymakers, especially for those that consider a shift towards an NDC scheme. By providing an assessment of the current and predicted impact of population ageing on the sustainability of the pension system, this section attempts to provide a clear picture of the aging challenges that currently affect pension provision. As a second purpose, this section will provide a starting comparative point for the results of the model that is going to be used further along for the implementation of an NDC system in Portugal. Additionally, the European Commission has been following ageing trends in Europe and has tentatively assessed their impact on

public expenditure that has culminated in the production of the Ageing Report, a crucial source of data that will be systematically used in this chapter for analysing the predicted impact of population ageing on the sustainability of the Portuguese pension system. The reports are usually released every three years and include projections up to 2060 for age-related expenditure items: pensions, health-care, long-term care, and education and unemployment expenses. Finally, the reports also contain different types of scenarios according to parameters such as high life expectancy for example. For the purpose of this exercise, only the baseline scenarios will be used. When relevant, there may be mention to different scenarios, however, the baseline scenario will constitute the centre of this analysis.

3.2.1. Demographics

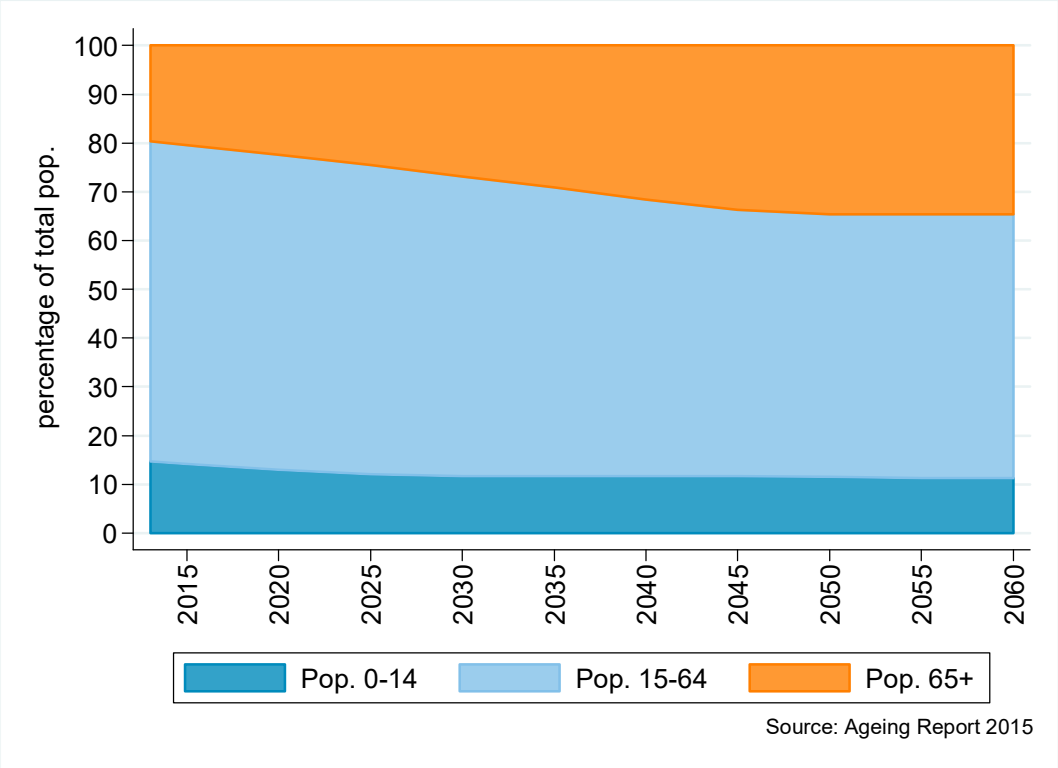
As a start to this analysis, I will look at how the demographic dynamics are expected to evolve according to the Ageing Report (2015). According to the projections by the Ageing Working Group (AWG), the total population in Portugal is expected to decline from 10.3 million individuals in 2015 to 8.2 million in 2060, representing a decline of 21.9 percent (*Figure 2*).

Figure 2 AWG Projections: Total Population in Portugal, 2015-2060



In terms of distribution across age groups, *Figure 3*, clearly shows an expected increase in the proportion of elderly population accompanied by a thinning of the share of population in working age. Overall, the share of individuals aged 65 and over is expected to increase from 20.45 percent of total population in 2015 to 34.6 percent in 2060, representing an increase of 69.2 percent.

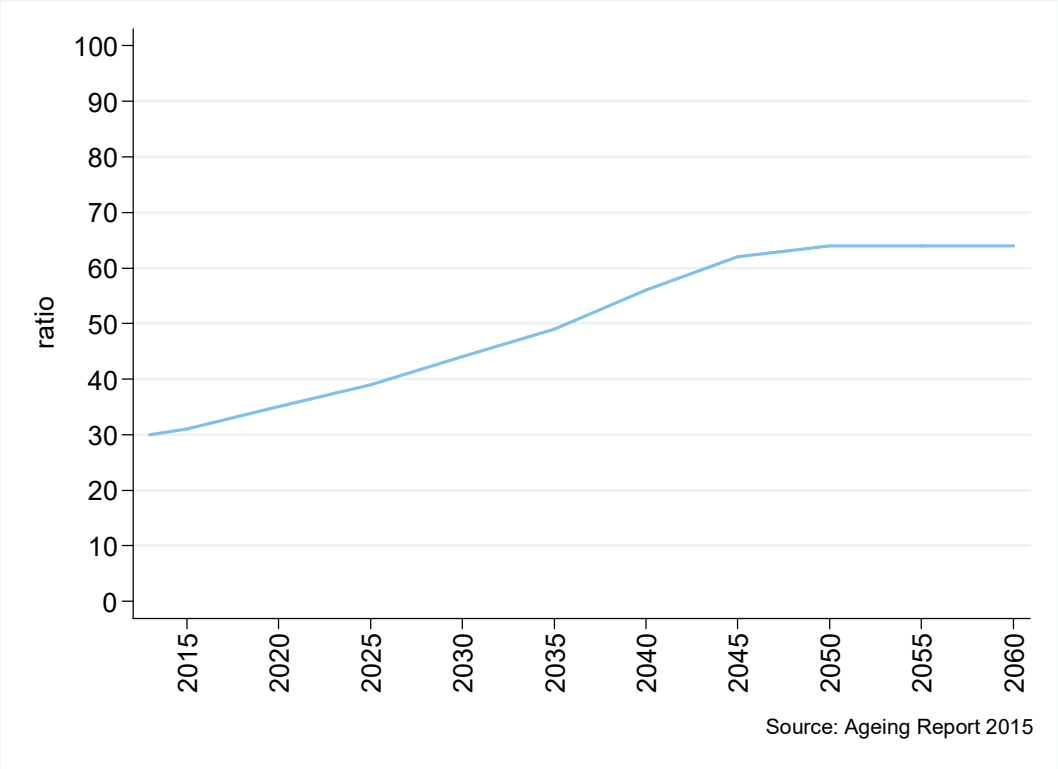
Figure 3 AWG Projections: Population Age Distribution in Portugal, 2015-2060



Overall, the projections of the Ageing Report (2015) show a decrease in total population associated with a relative increase in the share of individuals aged 65 and over. It is important to note that population ageing is a very dynamic phenomenon and its impact is, in fact, widespread across many different levels of society. One of the aspects that often drives concerns about population ageing is the possibility of an increased financial burden on the pension system. In order to shed some light over this issue, it is often helpful to look at the old-age demographic dependency ratio. For the purpose of this exercise, the old-age demographic dependency ratio is defined as the ratio of individuals aged 15-64 years old to individuals aged 65 and over. As shown in *Figure 4*, the old-age dependency ratio is expected to increase substantially, from 31 in 2015 to 64 in 2060. This means that while in 2015 there were 31 individuals aged 65 and over per 100 individuals in working age, by 2060, the AWG projections expect that the number of individuals aged 65 and over per 100 individuals in

working age increases to 64. This means that Portugal is expected to move from a ratio of 3.3 individuals working for every elderly person to a ratio of 2 to 1. An increase of this magnitude in the old age dependency ratio can be expected to have significant consequences on the ability of the pension system to finance its pension liabilities.

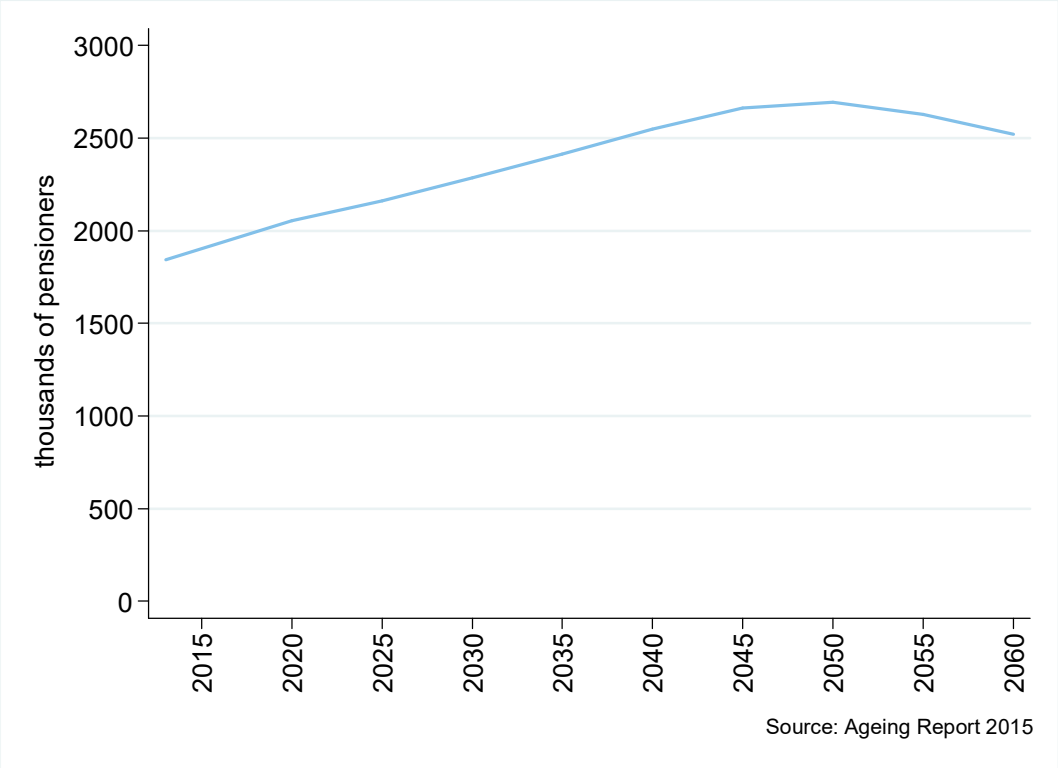
Figure 4 AWG Projections: Old Age Dependency Ratio in Portugal, 2015-2060



3.2.2. Pension Demand

According to the demographic dynamics described above, it is expected that there should be a dramatic increase in the number of pensioners. According to the projections of the AWG (2015), the number of pensioners aged 65 and over is supposed to increase by 36.77 percent, from 1 844 thousand pensioners in 2015 to 2 522 thousand pensioners in 2060.

Figure 5 AWG Projections: Total Pensioners aged 65 years old and over in Portugal, 2015-2060

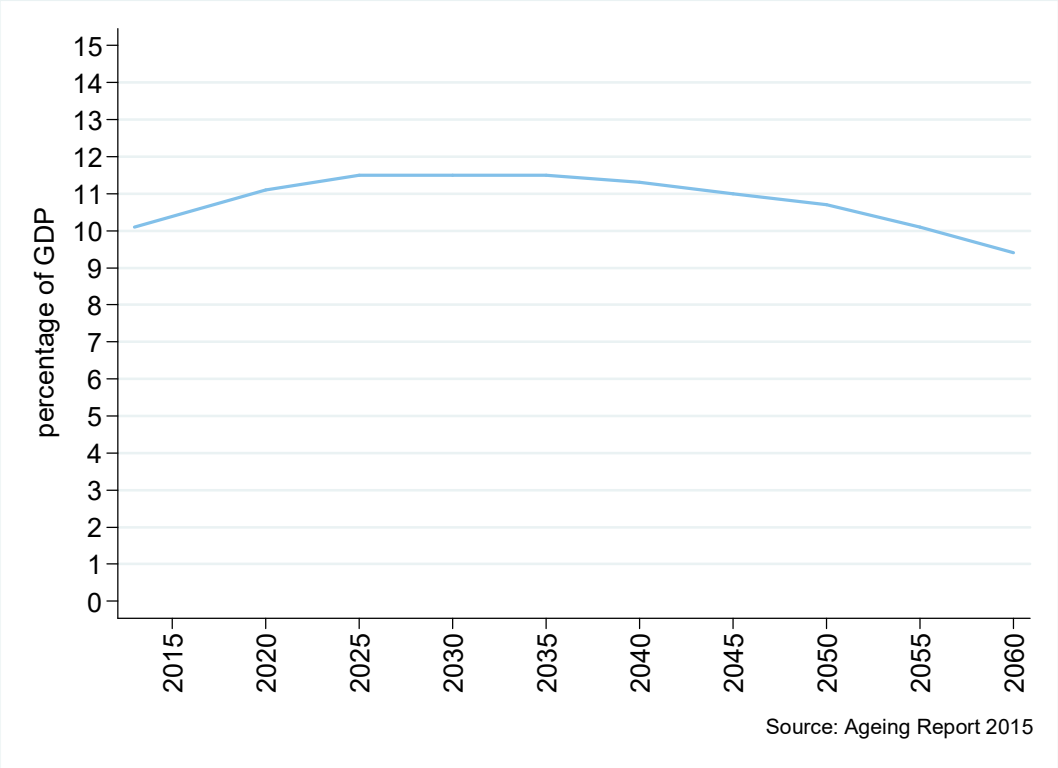


Overall, these projections show the expected increase in pension demand that is to be expected if we consider the previous demographic scenario.

3.2.3. Expenditure

In terms of expenditure, *Figure 6* shows that according to the AWG (2015) projections, the expenditure with old age pensions is expected to increase in the first few years, from approximately 11 percent of GDP in 2015 to 11.5 percent in 2035. From this point onward, total expenditure with old age pensions is expected to decrease, reaching 9.4 percent of GDP in 2060. The reason for this expected decline is related to the underlying assumptions that guide these projections. Since the macroeconomic scenario used to perform these projections assumes a population decline of 21.9 percent throughout the simulation, it is natural that expenditure with old age pensions also decline. Even if the relative share of the elderly increases, the real numbers portray a different picture. Additionally, this projections have a relatively positive assumption regarding GDP growth, with an average growth-rate of 1 percent.

Figure 6 AWG Projections: Total expenditure with old age pensions as a percentage of GDP in Portugal, 2015-2060

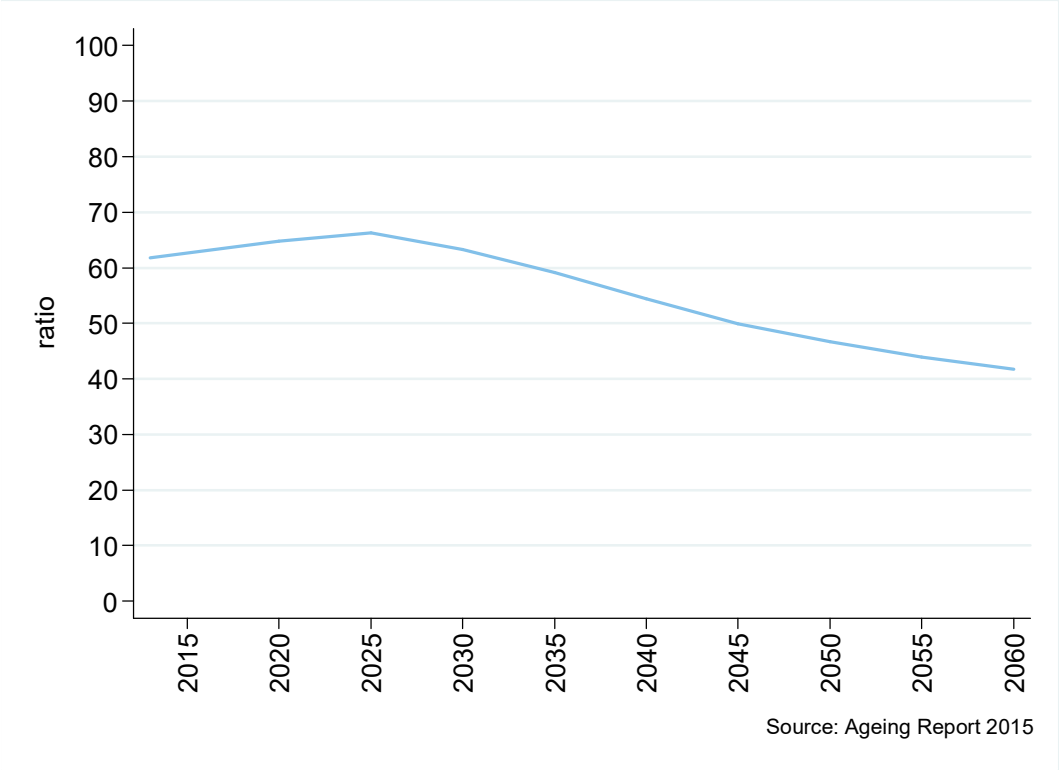


3.2.4. Adequacy

The final indicators that I will look at are the benefit ratio and the gross replacement ratio. The benefit ratio is a measure of adequacy that is used to analyse how pensioners fair against the remaining of the economy. As such, the benefit ratio is calculated as the ratio of the average old age pension and the average salary of the economy. The other measure of adequacy provided by the AWG (2015) is the gross replacement ratio. The gross replacement ratio is calculated as the ratio between the old age pension and the last salary earned by the individual. While the benefit ratio determines the position of the pensioner in relation to those that are still actively participating in the economy, the gross replacement ratio analyses the ability of the pension system to smooth income in the old age.

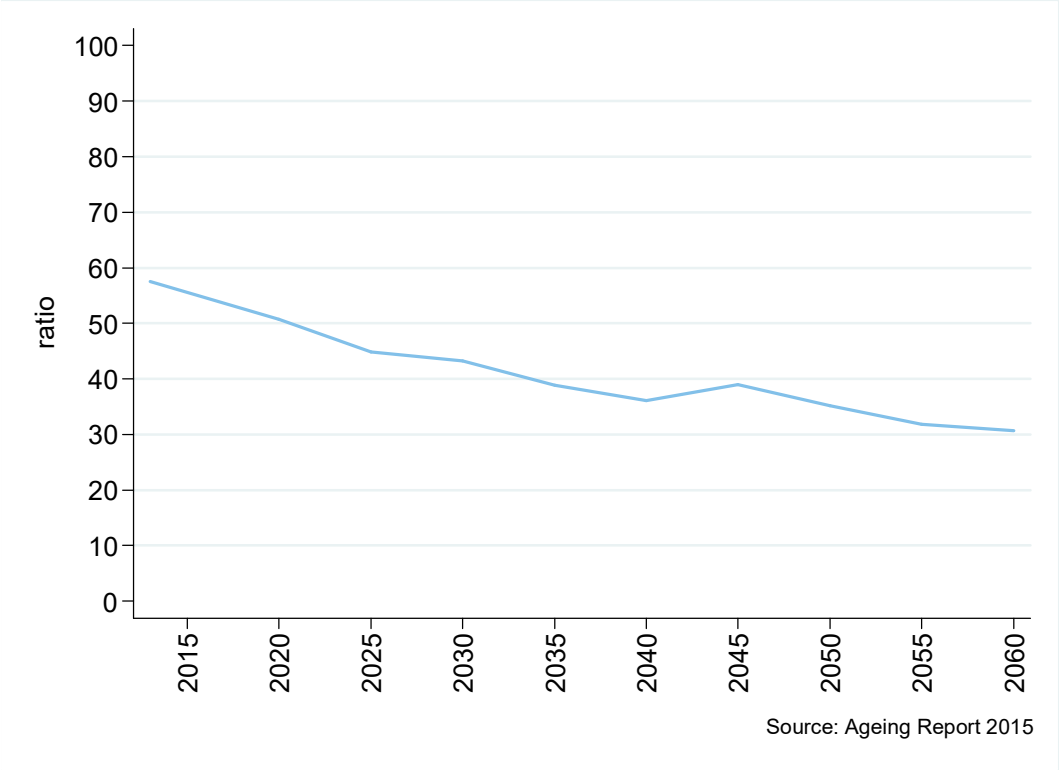
According to the projections of the AWG (2015), the benefit ratio for old age pensioners is expected to decrease, from 61.8 in 2015 to 41.7 in 2060, representing a decline of 32.52 percent (Figure 7). Overall, this means that the level of pensions is expected to decline in relation to the salaries.

Figure 7 AWG Projections: Benefit Ratio in Portugal, 2015-2060



Finally, with regards to the gross replacement ratio, the AWG (2015) projections show a considerable decline, from 57.5 percent in 2015 to 30.7 percent in 2060. Overall, this represents a decrease of almost 50%, which in turn means that the system is expected to lose almost half of its ability to smooth consumption in old age.

Figure 8 AWG Projections: Gross Replacement Ratio in Portugal, 2015-2060



3.3. Conclusion

After an analysis of the projections of done by the Ageing Report (2015), it is easy to paint a pretty bleak picture of the expected sustainability of the pension system in Portugal. Overall, there is an expected increase in the relative share of the elderly associated with a decline in the relative share of the working age population. Consequently, in the eventuality that there are no changes to the pension system, this would inevitably translate into a decline in the level of contributions. Additionally, the projections show a substantial increase in the number of pensioners. Although expenditure as percentage of GDP is decreasing, I believe these results are mainly due to the assumptions behind GDP growth. At the same time, in terms of adequacy, the projections show a considerable step-back in the generosity of the system, with both benefit-ratio and gross-replacement ratio showing an expected drop.

Chapter 4: Transitions to NDC pension schemes

4.1. The Swedish Experience

4.1.1. The pension system before reforming to NDC

By 1950, the Swedish pension system had already experienced three pension reforms which culminated in the introduction of a flat-rate basic pension called '*Folkpension*' (FP) (Konberg et al., 2006). Implemented in 1948, the FP was introduced with the aim of increasing the general standard of living for the elderly. According to Hagen (2013), while the FP had indeed increased the general standard of living for the elderly, it still only amounted for 35 percent of the average wage in the industrial sector. As an income replacement measure, this is still a very low figure and was especially criticized among high earners that were accustomed to a higher standard of living. This meant that as individuals transitioned into retirement, they would experience a great drop in the level of earnings that they had experienced up to that point. Additionally, a flat-rate benefit meant that as real-wages increased, pension amounts would remain constant over time creating an increasing income disparity between pensioners and workers. As a result, several labour market groups opted to supplement their basic pension with occupational pension arrangements in order to increase their income in old age (Hagen, 2013).

Eventually, pensioners started growing displeased with this situation. The discontent was especially felt among blue collar pensioners that relied mostly on the FP pension as a primary source of income, since they did not include pensions in their negotiations with their employers. This led to one of greatest political confrontations in Swedish history. Indeed, the introduction of a supplementary pension scheme was a highly politicized event in Sweden. On the one side there was the political right, backed by the Swedish Employer's Federation that idealised either a universal flat-rate scheme or voluntary occupational pensions. On the other, the Social Democrats (SAP), encouraged by the blue collar trade unions that were set on a compulsory, legislated and state-run scheme that guaranteed similar benefits for all individuals in spite of their category of employment (Olsson, 1990).

The debate regarding the introduction of a supplementary pension scheme was lengthy and fierce. The SAP held as many seats in parliament as the opposition parties, which led to a tie when it came to voting. Efforts were made to attempt to negotiate and find a middle ground between the parties, however the differences between them were too great and both sides struggled to reach an agreement. One of the aspects that should be taken into account when considering the debate that led to the ATP scheme, is that social policy not only guarantee's against the loss of income, but is also able to result in a stratification of different groups of individuals. In fact, this is a central premise of Bismarckian social protection schemes, where individuals were entitled to different benefits according to their employee group (Kangas, Lundberg, & Ploug, 2010). According to Esping-Andersen (1985), in the Swedish case, Social Democrats attempted to do exactly the opposite. Instead of segregating the different groups of employees, they attempted to bag all employees in the same risk pool which, they hoped, would generate a general feeling of comradery that would eventually culminate in a common class identity. As a result, in 1960 the ATP was introduced in Sweden as an attempt to address the inequality between blue and white-collar workers by introducing a statutory defined benefit (DB) earnings-related pension for all employees.

4.1.2. The ATP pension system

The ATP pension system that resulted from the political debate consisted in a mandatory pay-as-you-go (PAYG) scheme that covered all employees. An ATP pension was to be paid out to every individual that earned pensionable income for a minimum of three years. Pensionable income here refers to working income between the ages of 16 and 64 years old between 1 and 7.5 base amounts that correspond to an assessed sum based on consumer price index which makes it so that the pension income is indexed to inflation.

As previously mentioned, the introduction of the ATP followed a loss-of-earnings principle. This meant that the size of an individual pension should reflect the level of earnings that the individuals experienced during their working live. In order to tie the calculation of the pension value to previous

earnings, the ATP is calculated by considering pensionable income from the best 15 of the last 30 years of earnings. According to these rules, the annual pension amount an individual is entitled can be calculated from the following formula:

$$P = 0.6 \times pB \times \frac{t}{30}$$

where P is the annual old age pension; *pB* is the average value of pensionable income during the best 15 of the last 30 years; and *t* is equivalent to the contributory career. Basically this shows that there was a break of 40% in individual income associated with retirement. The final section of the equation applies of penalty of 1/30th of the calculated pension value per year under the 30 years of contributions. Additionally, there was an extra rule that stated that t/30 <= 1. This rule was created in order to ensure that, while individuals received penalties for having less than 30 years of contributory career, individuals that accumulated pension credits for more than 30 years would not be able to claim a higher ATP pension.

Finally, the statutory age of retirement under this scheme was 65 years old. However, individuals were allowed to collect their pension earlier, while facing early retirement penalties, or later (Herbertsson, Orszag, & Orszag, 2000). Before the transition to the NDC scheme, early retirement was allowed as early as 60 years old in exchange for a reduction of 0.5 per month before the statutory age of retirement, accounting for a total of 6% of pension value per year. In cases where individuals postponed their retirement past the statutory age of retirement, they would collect a pension increase of 0.6 percent per month after the statutory age of retirement up to seventy years of age. However, these possibilities were not often used by Swedish contributors. Instead, most early retired individuals were mainly self-employed (Herbertsson et al., 2000).

4.1.3. The trend towards early retirement

At the time the ATP was first introduced, the retirement age was set at 67 years old. However, several occupational schemes at the possibility of retiring earlier, at the age of 65. This meant that individuals

would retire at the age of 65 and would receive a full pension until they reached the official retirement age, when they would be able to withdraw a full pension from the ATP. However, in the 1970s, several changes were implemented in this regard. First, the official retirement age was lowered to 65 years old. Second, individuals were allowed to withdraw their pension benefits from as early as 60 years old or postpone retirement up to 70 years old, with an actuarial adjustment that penalised early retirees by 0.5% per month (6% a year) before the age of retirement or rewarded late retirement by 0.5-0.7% per month after 65 years old (Sundén, 2006). Third, there was the introduction of partial pensions which allowed individuals between the ages of 60-64 to withdraw pension benefits while they remained at work. In order to be eligible for this particular pathway to retirement, an individual was required to have accumulated pension credits for at least 10 years since the age of 45. Additionally, individuals were forced to reduce their number of working hours per week by 5, whilst continuing to work at least 17 hours per week. In return the government would compensate up to 65% for the loss of income associated with this regime. According to Glans (2008), this system was especially generous since the high marginal tax rates at the time implied that the net replacement rate was actually a lot higher than the advertised 65 percent.

Finally, disability insurance was increasingly used as a pathway to retirement (Sundén, 2006). In an attempt to increase income security for the elderly workers with physically demanding working conditions, there was an increase in the generosity of the disability insurance program – from one third to a half of a full pension – and a loosening of the eligibility conditions – from 63 to 60 years old (Hagen, 2013). In this case, the size of the disability benefit was calculated in the same way as the ATP, with an assumed earnings profile. In their work, Jönsson, Palme, and Svensson (2011) show that there was a great decrease in the participation of elderly individuals in the labour force between 1970 and 1988, which was associated with an increase in the number of disability insurance recipients. In their work, they find that between 1970 and 1988, for individuals aged 60-64 years old, non-employment increased by 15 percent, non-labour force participation by 15.5 percent and disability insurance recipients by 15.2 percent. They conclude that disability insurance appeared to be the main pathway

to retirement for older males up to 1990. As a result, Sundén (2006) points to the fact that while the official retirement age may have been 65 years old, actual retirement age was, in fact, around 62 years old for men.

4.1.4. The reasons for the reform of the Swedish Pension System

The implementation of the new ATP system was considered as a great victory by the Social Democratic Party in Sweden. In fact, the system quickly gained a great deal of followers since it almost immediately improved the socio-economic position of the elderly through the means of generous transition rules. As a result, the system remained virtually untouched for a few decades. In line with this situation, Hagen (2013) notes that due to the fact that the ATP design turned out particular beneficial for liberal and conservative high-income workers, since it was particularly beneficial for people with short working careers, the main force behind the new call for pension reform was not of an ideological nature. Instead, the author argues that the new call for pension reform in Sweden resulted from the fact that the ATP system was afflicted by inherent financial instability. Indeed, the "crown jewel" of the SAP was at the mercy of forces beyond its control such as demographic and socio-economic changes.

According to Anderson (2005), the rapid deterioration of the Swedish economy associated with the rapid increase in the unemployment rate dramatically altered the economic and political foundations of the pension system. Demographic and economic pressures reached Sweden as early as the 1990s. In fact, during the period between 1991 and 1992, Sweden experienced a short economic recession that culminated in a sharp increase in unemployment (OECD, 2016). As shown in *Table 2*, it is clear that there has been a spike in unemployment that began in 1990 with 2.11 percent, reaching levels as high as 11.6% in 1997. Additionally there was a clear decline in GDP growth in the early years of the 1990s, which were accompanied by a decline in labour force participation of individuals aged 15 to 74 years old.

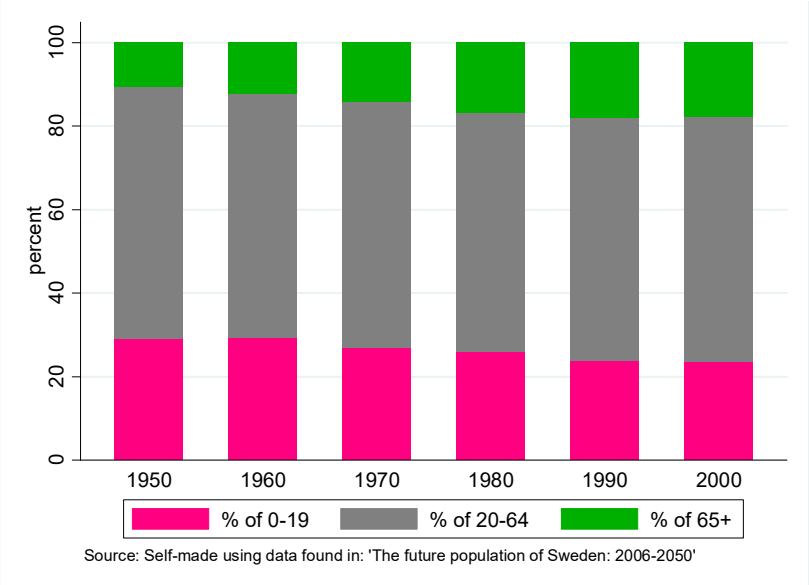
Table 2 Unemployment Rate, GDP growth and Labour Force participation in Sweden, 1990-1999

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Unemployment rate	2.113824	3.745729	6.625434	10.74336	11.15275	10.47517	11.40307	11.66519	9.708046	8.197415
GDP growth	0.754675	-1.14597	-1.15859	-2.06562	3.917449	4.24837	1.542361	3.121499	4.127259	4.266788
Labour force participation	74.21682	73.5989	72.40114	71.08929	70.72311	70.78821	71.14216	70.74533	70.35617	70.7002

Source: OECD Economic Outlook Data No. 99

The other force that was identified as a primary contributor for the political debate and the call for a new pension reform was population ageing. Indeed, like many other industrialized countries, Sweden also felt the demographic phenomenon of population ageing. According to data from the Statistics Sweden (2008) Forecasting Institute, the population of Sweden is characterized by a growing number of elderly (65 years old and over) and a shrinking demographic of younger individuals (under 20 years old).

Figure 9 Population by age group in Sweden, 1950-2050

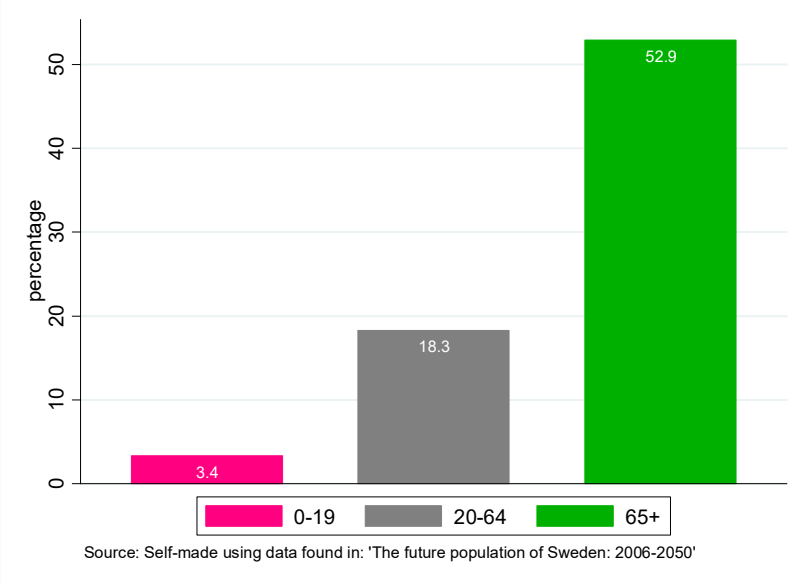


Source: Self-made using data found in: 'The future population of Sweden: 2006-2050'

As illustrated in Figure 9, the share of individuals aged 65 and over doubled during the period between 1950 and 2000, while the share of younger individuals has slowly decreased overtime. Another aspect that is important to note is that the share of working age population is shrinking. Although the

shrinking of the working age demographic seems evident here, in terms of actual numbers, it is not so clear cut. In fact, the number of working age individuals increased from 4.26 million to 5.21 million individuals between 1950 and 2000. While the number of people in working age is rising, its proportion slowly declined over the years. This results from the fact that the number of elderly individuals is increasing at a higher rate than the other groups represented in the figure. This means that in relative terms, there is a decrease in the share of working age population to elderly. This is best illustrated in Figure 10, which shows the percentage change in the number of individuals in each age group considered here.

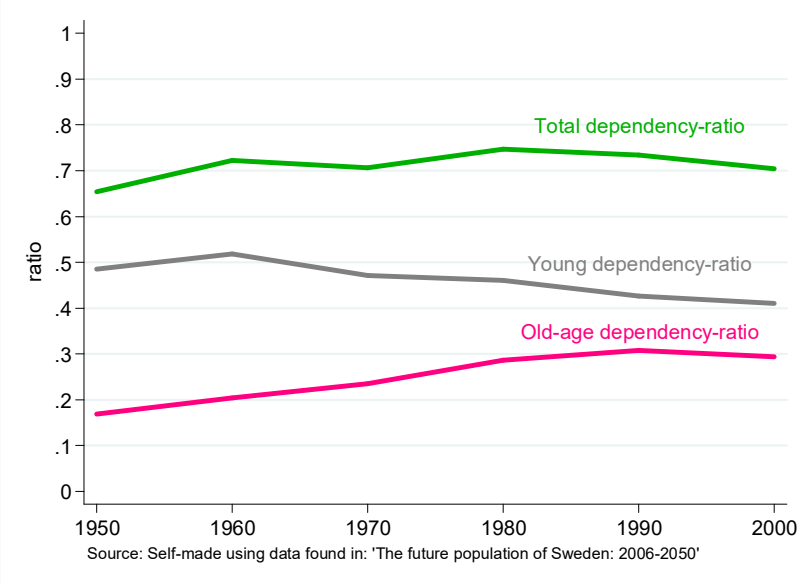
Figure 10 Percentage change in population by age group in Sweden. 1950-2000



It is clear to see that, although all age groups have experienced an increase between 1950 and 2000, the one that expanded the most was in fact the elderly with a 52.9 percent increase, in comparison to 18.3 percent for working age population and a small 3.4 percent increase. This shows that during the period that lead to the reform of the Swedish pension system, not only was the population of Sweden increasing, but it was also growing increasingly older. The weak rise in the share of working age population in comparison to the staggering increase in the share of elderly individuals experienced in Sweden was a major factor that contributed to the call for a new pension reform. The pressures that arise from a demographic change this big are best illustrated in the form of a dependency ratio. The

dependency ratio here is calculated using the data from the Statistics Sweden (2008) report and considers the ratio between active age individuals (20-64 years old) and those outside active age (0-19 and 65+ years old). Additionally, the old age dependency ratio and the young dependency ratio were calculated. This measure can be seen as a measure of the burden that is placed on the working population, and it is often used when assessing the economic impact of population ageing (Statistics Sweden, 2008).

Figure 11 Evolution of Dependency Ratios in Sweden, 1950-2000



As illustrated in *Figure 11,* the total dependency ratio has increased between 1950 and 2000. A striking feature of this increase in the total dependency ratio is that it is mostly a result of the increase in the old-age dependency ratio, since the young dependency ratio has actually decreased during this period. A high dependency ratio is often indicative of an increased burden on the working population, since it is assumed that the economically active part of the population will need to finance the non-active population (Ingham, Chirijevskis, & Carmichael, 2009). In this case, Sweden was not an exception. The increasing dependency ratio was swiftly accompanied by an increase in social expenditure. Since the increase in the dependency ratio was mostly a result of the increase in the share of the elderly, this increase in social expenditure came in the form of pension expenditure.

Indeed, the ATP aka the Socialist Party "*crown jewel*" was facing serious financial problems. With an increase on the expenditure side, resulting from a growing share of elderly individuals due to population ageing, associated with a slow growth of working age population, the relative share of individuals in working age to those aged 65 or over was rapidly decreasing. This meant that there was less revenue that was meant to support a growing number of pensioners, directly affecting the long-term sustainability of pension system should it remain unaltered. Since the ATP system was linked to benefits, adjustments to financial imbalances had to be made through an increase in the contribution rate or by decreasing the pension level. However, each of these measures would, in essence, represent a "breach of contract". On the contributory side, an increase on the contribution rate would represent a threat to the essence of the system. On the pensioners end, it would mean individuals collecting pensions lower than the pensions they had contributed for. This meant that Sweden was "stuck" in a position of financial instability, without any politically viable reform solutions.

In the view of the supreme decision-making body of Sweden, the Riksdag, this situation was unacceptable. The Swedish pension system was open to a variety of risks that threatened its financial sustainability. Additionally, any reform option would threaten its legitimacy.

In the end, it can be said the call for a new pension reform was, in fact, the result of a combination of factors. Demographic shifts associated with concerns over the sustainability, the very well-known recipe for igniting debates on pension reform, led to the realization that the system that was in place at the time was unable to maintain its very own sustainability in the long run. Additionally, the recession of the early 1990s appears to have cemented this belief (Sundén, 2006). Talks about the need for pension reform started as early as the mid-1980s, when the government appointed a commission (Pensions Commission) to produce a study regarding the difficulties faced by the pension system. In 1990, the Pensions Commission concluded that in the ATP and basic pension system that was in place at the time was not sufficiently robust to withstand socio-economic and demographic pressures (MHSA, 2010). All of these pressures culminated in the parliamentary bill 1993/94:250,

where the Swedish government assessed that the current national pension system was unable to meet the necessary requirements of a pension system and called for a complete reform and "modernization" of the pension system that would guarantee its survival in the long-run (MHSA, 2010).

In spite of the general agreement that the pension system was in dire need of reform, the politics of that reform were still up for debate. In the 1991 general election, the Social Democratic party was relieved from office by a four-party liberal/conservative government. In their view, pension reform was seen as a top priority and a new parliamentary group of seven representatives (one from each party) was elected (Sundén, 2006). The possibility of making changes within the framework of the ATP system in order to transform it in a more robust system capable of withstanding financial pressures was investigated by the group. However, the conclusion was that the gravity of the situation called for a structural rather than parametric reform in order ensure the future of the system (MHSA, 2010).

In this respect, the more conservative parties suggested a privatization of the system, which was quickly rejected by the Social Democrats that strongly argued for the system to remain public and on a PAYG basis (Sundén, 2006). In the end, a compromise was reached and Sweden shifted from a benefit-based to a contribution-based system. This system was something unseen at the time. A new pension system that combined both PAYG and DC elements was agreed upon in 1994 with a parliamentary acceptance of 80% (Sundén, 2006). During the following 4 years, all the details of the system were worked out and in 1998 the new NDC plan was created.

The fact that the new system was designed by several parties is noteworthy in this case. One important aspect of the reform process was the emphasis in designing a system that was both financially and politically stable. The creation of a long-term financially stable pension system is a huge undertaking that may last for several years. In order to guarantee its legitimacy, it is necessary that the new pension system is able to fully insulate itself from the political spectrum.

4.1.5. The new pension system in Sweden

The current National Pension System in Sweden consists of a mandatory program that is designed across three tiers of pension provision. The first tier is composed by the *inkomstpension* that represents the basic income pension financed through a defined contribution. The second tier consists of the Premium Pension Plan (PPP henceforth). Finally, the third tier is *Garantipension* (Minimum guaranteed pension or MGP henceforth), which is a means test supplement that insures individuals with no or very low income pensions. The *inkomstpension* is a NDC scheme and represents the main part of the pension system financed via a contribution rate of 16 percent. The PPP is a FDC scheme that is financed via a 2.5 percent contribution rate. Finally, the MGP is financed via the general tax revenue. This puts the total contribution rate for the financing of the pension system at 18.5 percent.

4.1.5.1. The Ikomstpension: the NDC part of the system

The main part of the new pension system introduced in Sweden is the inkomstpension, an NDC aimed at replacing its predecessor, the ATP. Whereas the ATP was a defined benefit scheme, the inkomstpension is a defined contribution scheme and was specially designed with financial stability in mind. By directly linking pensions to the accumulated contributions, policymakers reduce the risk of uncertainty regarding the size of future pension commitments. Additionally, since NDC take into account an individuals' entire career rather than just the best 15 or 30 years, it ensures a greater degree of actuarial fairness when compared to traditional PAYG defined benefit schemes, which greatly inflate the level of pension benefits by using only a predefined portion of the career with highest earnings (Legros, 2006). The main difference from this new NDC scheme to other defined contribution schemes, namely the FDC, is that it maintained the PAYG feature of current contributions paying out current pension benefit obligations. Hence, the values credited in individual accounts are non-financial, which explains the designation of notional.

The financing of the *inkomstpension* can be dissected into three different sources of contributions: individual contributions, employer's contributions and the state old-age contributions (Hagen, 2013).

The individual contributions, or general pension contributions, are paid by every employee and accounts for 7 percent of individual income in addition to other social benefits with a ceiling of 8.07 income base amount. The income base amount is used for the calculation of the individual pensions and refers to a fixed value that is determined every year by the government and follows income trend and variations across price range. The calculation of the income base amount is set by the *Inkomstbasbelopp* (the Swedish Social Insurance Office) (NGEPB Sweden, 2018). The employer's contribution refers to a payroll tax of 10.21 percent of individual wages for every employee. Additionally, if the individual is receiving a pension due to sickness, parental leave or enrolled in the military, he or she earns pension rights through the government old-age contribution of 18.5 percent paid by the State. From the total contribution rate of 18.5 percent, 16 percent is allocated to the financing of the NDC component, while the remaining 2.5 percent will go to the PPP. The 16 percent contributed to the *inkomstpension* is split into four equal parts and deposited across four buffer funds, which are used to finance current pensioners.

A very important change that should be taken into consideration when contrasting the new pension system in Sweden with its predecessor is the shift from the 15 to 30 best years to a life-income system. In principle, this can be considered a work reinforcement measure: additional years of work translate in a higher pension level. Basically, the Swedish NDC system has several features that benefit individuals that wish to extend their careers. Pension credits are accumulated from the age of 16 provided they surpass 24 percent of the income base amount. Additionally, pension credits can be accumulated after the age of 65. Individuals earning basic income after they are receiving a pension will still accumulate new credits and, ipso facto, earning new pension rights. These are very good incentives for individuals to remain active and postpone their full retirement from the labour market.

With regards to the official retirement age, the Swedish pension system innovated again. There is no official retirement age. Individuals may begin to collect their pension from the age of 61 years old and workers have statutory rights to work up to the age of 67 (Hagen, 2013). Contrary to a traditional DB

scheme, which will require a deduction for early retirement, an NDC pension is calculated in the same way whether an individual is 61 or 67. The difference between the pensions will be due to their individual notional accounts and not due to the age at which they retire.

4.1.5.2. Adjustments in the new pension system: the uninsurable risks saga

The new Swedish pension system was designed to be financially in a way that it will be able to finance its obligations with a fixed rate and fixed rules for calculations regardless of demographic or economic development. While these features will enhance the legitimacy of the system, it also entails the risk that the value of pensions will vary over time.

As previously mentioned, a major problem in the ATP system is that pension benefits were indexed to consumer prices. This meant that as real wage-growth increases contribution burdens will halt. On the other hand, if real wage-growth falls, contribution burdens will increase, making individuals especially vulnerable to economic fluctuations. In order to solve this problem, the rate of return in the new NDC system is determined by wage growth per capita. By linking pension benefits to wage growth per capita, the new Swedish pension systems guarantee's a stable relationship between the general standard of living of the working population and pensioners, which is more resilient to economic fluctuations. According to Hagen (2013), there were other options available that were considered for the calculation of the rate of return in the new NDC system. However, most of them did not distribute the risk equally and would probably require government intervention at some point.

Another problem that led to the pension reform in Sweden was the vulnerability of the system to demographic changes, namely population ageing. As a result, the new system was designed with an automatic adjustment that reflects changes in life expectancy, the annuity divisor. The annuity divisor reflects the unisex life-expectancy at the age of retirement. As such, at the age of 61, individuals are able to claim a full or partial (25, 50 or 75 percent) pension from the Swedish NDC system. Since there is no upper age limit, individuals can continue to work past this year earning extra pension credits. Additionally, individuals may combine their income with a pension in order to supplement their

earnings, and at the same time earning extra pension credits. An individual that claims their pension and continues to work, will have their pension recalculated based on their new notional account values upon permanent retirement. Following this logic, when an individual wishes to claim their pension, their annuity is calculated in the following way:

$$Annuity = \frac{Account\ Value}{Unissex\ Life\ Expectancy}$$

This way, the demographic uncertainty is counteracted automatically by a change in the Annuity Divisor, which means that pensions will somehow reflect Unisex Life Expectancy (ULE). For example, lets consider two parallel examples: example A with a ULE of 15 years and example B with a ULE of 25 years. Now imagine that an individual decides to retire with an account value of 100 units. In example A this would mean that the annuity would be equal to 100 / 15 which will give an annuity of 6.66. If the same individual retires in example B, the annuity would be 100 / 25 which results in 4. This shows that as ULE increases, the system automatically adjusts itself in order to maintain its sustainability, i.e. the new system is actuarial in nature.

Finally, there is an automatic adjustment mechanism. In essence, the Swedish pension system is not designed to be indexed by its internal rate of return. This has resulted in the development of a balance mechanism that works similarly to a balance sheet and adjusts the value of the internal rate of return should it present a threat to the sustainability of the system. The balance mechanism works by calculating the ratio between assets and liabilities of the pension system by using the formula:

$$Balance\ ratio = \frac{Contribution\ Assets + Buffer\ Fund}{Pension\ Liability}$$

The balance ratio given by the formula provides a summary of the risk the system is currently experiencing. When the balance ratio is above 1, it means that the system is financially safe. The value of the assets exceeds the pension liabilities and the system is able to meet its obligations. On the other hand, when the balance ratio is under 1, it means that the system is in a state of financial imbalance

and that the liabilities exceed the funds that were to finance it. At this point, if this situation persists, the buffer fund would eventually be depleted. In order to avoid this situation, the automatic balance mechanism is activated. At this point the method of pension indexation is switched to a new indexation series called the *balance index* (Settergren, 2001). The balance index is calculated by multiplying the income index by the balance ratio, which will result in a lower rate. These lower accrual rates and indexation continue until financial balance is restored. Once the balance is restored and above one, the accrual rate and indexation is increase above normal levels during a catching up period.

4.1.5.3. The PPP – FDC part of the system

The premium pension is the second part of the system. As previously explained, this section of the pension system is financed via a contribution rate of 2.5 percent that when added to the 16 percent used to finance the NDC part of the system makes up the full 18.5 contribution rate. Contributions to the PPP are withheld by employers and then paid out to the Premium Pension Agency (PPA), which in turn keeps track of all individual accounts and execute desired portfolio investments. According to Sunden (2006), the introduction of mandatory individual accounts in the new Swedish pension system represents a compromise between the political parties involved in the system design, which allows individuals to take account of the higher return in the capital markets as well as to tailor part of their pension according to their risk preferences. Additionally, there is a broad choice of funds that individuals may choose from (Sundén, 2006).

Benefits from the PPP are paid out annually and can be withdrawn from the age of 61, the same age as the NDC pension. It is important to note that the PPP pension can be withdrawn together with or separately from the NDC pension. At the time of retirement individuals can chose to withdraw their pension in one of two different ways. On the one hand, individuals may opt by converting their pension into an annuity in order to avoid any further investment risk. On the other hand, individuals may decide to remain investing their pensions and withdraw only a variable annuity.

4.1.5.4. The Garantipension – minimum guaranteed pension

As we have seen in a previous chapter, one of the main objectives of a pension system is to provide adequate income to its pensioners. With this objective in mind, Swedish policy makers established a minimum guaranteed pension based on a means test that is offset by the income generated by the NDC. This pension is financed through general tax revenue and is very similar to the minimum pension values, or social complements, that we have in Portugal. This benefit is payed from the age of 65 years old and represents on average 35 percent of the wage of a blue-collar worker in Sweden providing 2.13 b.a. for single individuals and 1.9 b.a. for individuals in a couple (Sundén, 2006).

An important aspect to consider is that the minimum guaranteed pension is not the minimum pension an individual can receive in Sweden. In fact, due to actuarial reductions and automatic adjustments, as well as the fact that the *garantispension* can only be withdrawn at the age of 65, means that individuals that retire at the age of 61, for example, run the risk of receiving a pension that is lower than the *garantispension*.

Another aspect that is noteworthy is the fact that the minimum guaranteed pension is price indexed and rather than being indexed to real wage growth, such as the NDC part of the system. According to Hagen (2013), the reason for choosing a different indexation methodology is in order to maintain the role of the *garantispension* to a minimum. The author explains that as real growth increases, the value of the earnings-related pensions will also increase, possibly surpassing the threshold for the *garantispension* and ultimately reducing the number of beneficiaries of this supplement. The opposite is also true. When real growth decreases, the value of the earnings-related pensions will also decrease, translating into an increase in the number of pension beneficiaries eligible to receive the minimum guaranteed pension. Sundén (2013) argues that as the Swedish women begin to participate increasingly more in the labour-force, the overall level of earnings related benefit rises, the number of individuals eligible to receive a *garantispension* will decrease to a minimum.

4.2. The Italian Experience

4.2.1. The Pension System before the NDC

The original pension system prior to the reforms introduced in 1992 and 1995 was a traditional PAYG-DB scheme. In general terms, the pension amount for private sector employee's was calculated based on pensionable earnings, which in turn were determined as a 5 year moving average of individual earnings for the last years before retirement. A tax rate of 2 percent per year of contributions was applied to pensionable income, up to a ceiling of 40 years. This meant that individuals with a full contributory career could reach pension amounts that were about 80 percent of their pensionable earnings. There were no incentives for postponing retirement, since the years above 40 years of contribution would have no impact on the defined benefit formula. Self-employed individuals collected a lower pension since their pensionable income was actually determined by a 10 year moving average. However, they also paid substantially less contributions. For public employees, pensionable income was determined according to their last payment.

Regarding official retirement age, the limits were set based on sector and gender: public employees were only able to retire at the age of 65 regardless of gender; private sector employees could retire at the ages of 60 and 55 for men and women respectively; and finally, self-employed individuals could retire at the age of 65 and 60 for men and women respectively. Additionally, a key aspect of the Italian pension system was that beneficiaries had the option of retiring before the official retirement age with a full pension, provided they had a contributed to the system for a certain period, 35 years of contributions for private sector employees and self-employed and 20 for public employees.

Apart from self-employed pensions, which were indexed to inflation, pre-reform pensions were indexed to national wage growth. The system was financed via contributions from employers and employees with a tax rate of 26.4 percent in 1991.

4.2.2. Reasons for pension reform

4.2.2.1. The usual suspects

The history of the Italian pension system is, in many ways, very similar to that of other European countries (Franco, 2002). The traditional ailments of a PAYG-DB system were also a factor that contributed to the reform of the pension system. As shown in *Table 3*, during the period 1981-1984 and the years that preceded the reform, real GDP growth took a tumble. Additionally, Italy has been historically afflicted by a high degree of inflation. Although inflation ended up reaching more "acceptable" levels prior to the pension reform, it was still nowhere near the generally accepted 2 percent. Finally, as depicted in *table 1*, prior to the pension reform, Italy also suffered from a very low participation rate, i.e. the portion of employed individuals in the population in active age remained under 60 percent for the entire period in analysis.

Table 3 Economic Development in Italy, 1980-1993

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Real GDP	3.48	0.78	0.33	1.37	3.21	2.84	2.97	2.96	4.30	3.47	1.95	1.53	0.70	-0.86
Inflation	21.06	17.97	16.48	14.65	10.79	9.21	5.82	4.75	5.06	6.26	6.46	6.25	5.27	4.63
Participation Rate	58.32	58.52	58.44	58.02	57.89	57.97	58.52	59.08	59.27	59.27	59.48	59.16	59.27	58.36

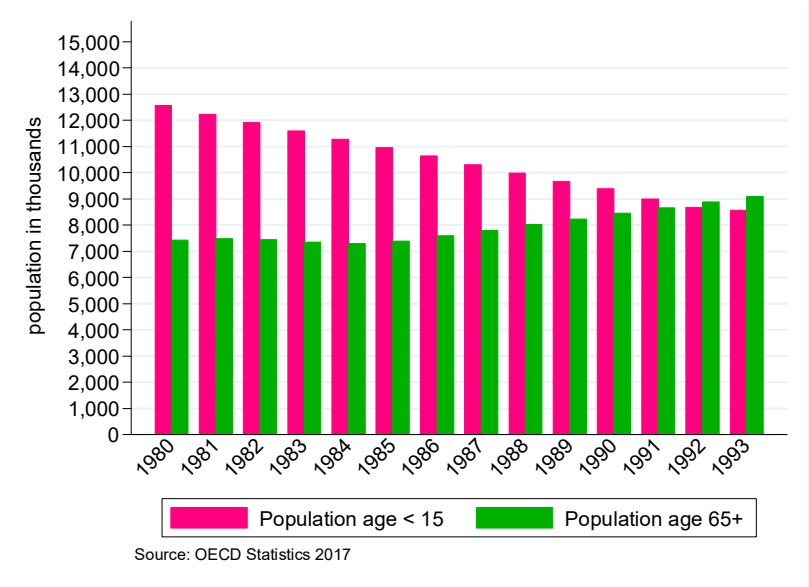
Source: OECD 2017

Taking into account that the Italian pension system was a traditional PAYG-DB system that was mainly financed by a tax rate on individual earnings, a low participation rate presented a threat to the sustainability of the system. Overall, this figure meant that out of the total population in active age, only 60% would be contributing to the system.

In addition to the poor performance of the development indicators in *Table 3*, Italy was also particularly affected by demographic changes. As shown in Figure 12*,* the population structure in Italy

changed dramatically in the relationship between individuals aged less than 15 years and individuals aged 65 or more years. The sharp fall in the number of children in Italy resulted from the low levels of fertility rates that lasted since the mid 1970's (Eurostat, 2017).

Figure 12 Population by age group in Italy, 1980-1993



4.2.2.2. Context specific

Problems with the Italian pension system data as far back as 1945. Indeed, in the aftermath of World War II, Italy was already facing problems related to the sustainability of its pension system. In her work, Franco (2002) identifies two possible causes for this early collapse of the financial sustainability of the system: first, rising inflation progressively led to an increase in pension expenditure; and second, the social security fund was being channelled to in order to support post-war government finances. As a result, in an attempt to maintain the sustainability of its social protection system, at the end of 1952, Italy reformed its pension system and altered its structure to a traditional PAYG-DB scheme. By 1962, the system was completely replaced.

During the 1960s and 1970s, system coverage was extended. Pensions were used as a tool to provide income support to individuals that would otherwise be entitled to them, such as individuals with short contributory careers for example. This policy was implemented with the use of existing pensions, such

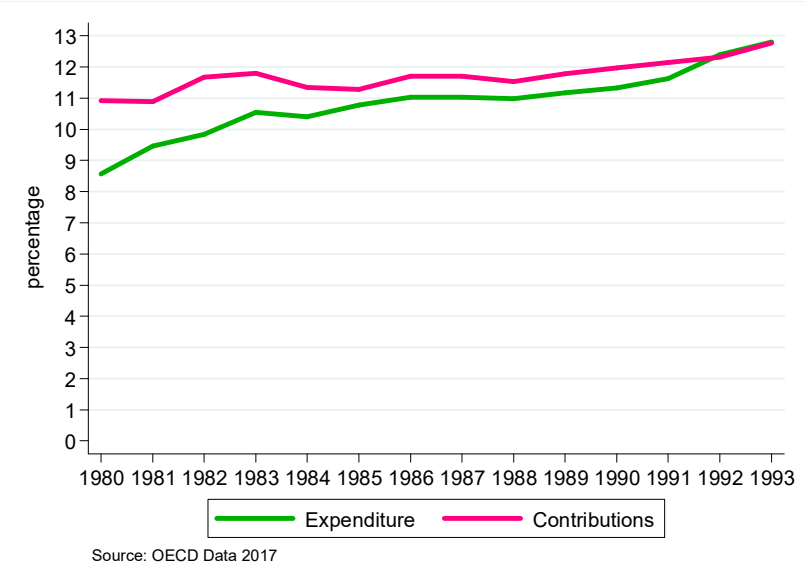
as disability pensions, and by creating new benefits. However, the improper use of disability pensions, associated with lose eligibility criteria, eventually led to a sharp increase in the number of new pensioners, and, as result, pension expenditure (Franco, 2002).

By the 1980's, the Italian pension system was composed by a single pillar defined benefit system that extended coverage through five different schemes: public sector workers, private sector workers, self-employed, farmers and artisans or shopkeepers. Alongside the public pension pillar there was a very peculiar scheme that could be considered an extra pillar of protection, the *trattamento di fine rapporto* (TFR). The TFR was a severance pay that firms were forced to pay their employees when they left their jobs, either due to old-age or any other reason. This 'scheme' was financed via contributions at a rate of 6.91 percent of annual earnings, which were accumulated and credited with an interest rate of 1.5 percent plus 75 percent of inflation rate (Ferrera & Jessoula, 2005).

Led by the expansionary measures undertaken in previous years regarding the generosity of pension benefits, the pension system in Italy began to reach a problematic standpoint. The Italian pension system had a quick evolution in terms of its generosity. However, associated with the expansion of the scheme also came the, often amazingly unforeseen, increase in pension expenditure. According to the study of a commission appointed by the Treasure Ministry in 1981, the system was clearly unsustainable and in dire need for reform (Ferrera & Jessoula, 2005).

The unsustainable nature of the Italian pension system became very clear in the following years as the gap between contributions and pension expenditure quickly shortened. As shown in *Figure 13* pension expenditure quickly increased in the time before pension reform. While the contributions paid to Social Security also increase, the rise in pension expenditure was a lot faster than the increase in contributions. The shortfall between contributions and pension expenditure led to a fundamentally unsustainable situation in 1992, where the necessary budged to meet expenditures was not met.

Figure 13 Pension Expenditure and Social Security contributions as a percentage of GDP in Italy, 1980-1993



In their work, Brugiavini and Fornero (1998) identify three major aspects that eventually led to the reform of the pension system in Italy. First, the extreme generosity of the benefits paid out, which were mostly characterized by a very high replacement rate. Second, a clearly visible financial imbalance, as shown in the previous graph. And finally, a pervasive redistributive feature. According to the authors, it was common for policy makers to make use of differential treatments across funds to gain political consensus.

As a consequence of the weakening of the Italian pension system, in the early 1990s, the government enacted a series of reforms. Government intervention began as early as 1992, with the introduction of the Amato reform. The immediate objective of the 1992 pension reform was to reduce pension expenditure (Pollnerová, 2002). The reform consisted of the introduction of a series of parametric changes that had the objective of improving the financial sustainability of the system and hamper its demise. Among these, there was the obviously necessary increase in the minimum contributory career in order to withdraw a full pension; increase in the in the statutory retirement age; increase in the reference period used to calculate pensionable income from the previous 5 years to 10 years for individuals with at least 15 years of contributions and the full career for new labour market participants; and replaced wage indexation by an indexing pensions to inflation instead.

In addition to the primary objective of reducing pension expenditure, the Amato reform had a secondary objective: to harmonize the different regulations of the pension system. While relevant in terms of cost containment, the results of the pension reform enacted in 1992 were somewhat reduced by the introduction of long transition periods (Ferrera & Jessoula, 2005). According to Hamann (1997), the introduction of the Amato pension reform was too slow and left two problem areas fundamentally unsolved: high contribution rates and the abolition of the system would have been unable to handle the demographic transition. In spite of its "failure", the Amato reform provided the framework in which a more comprehensive reform could be developed and implemented, which leads us to the introduction of the NDC pension in Italy under the Dini pension reform of 1995.

4.2.3. The new NDC system

The 1995 pension reform in Italy, often referred to as "Dini reform", completely changed the basic rules of the pension system. Although the primary goal of the previous reform was primarily to reduce pension expenditure, the new reform had a wider range of objectives. In his work, Rostagno (1996) identifies three primary objectives of the new pension reform: first, similarly to the previous reform, to reduce pension expenditure as a percentage of GDP; second, to reduce labour market distortions; and third, to reduce system inequalities and create a system that is fairer. With these guiding principles, the primary solution found by Italian policymakers was to follow in the footsteps of Sweden and create a new system that would tighten the links between contributions and benefits paid, which led to the introduction of the NDC component of the pension system. Note that I have called it a component rather than a brand new system. This was intentional. Contrary to the case of Sweden, the Italian pension reform has been a gradual process that has maintained a great number of individuals in the old system. Essentially, the new rules introduced by the Dini pension reform can be summarized as follows:

- For those that have started working after 1995, the pension is calculated by capitalizing their contributions over the course of their lifetime at the rate of growth of nominal GDP. The final

pension amount is determined by multiplying the capitalized contributions by a transformation coefficient that is indexed to retirement age.

- For those that in 1995 had more than 18 years of contributions, their pension amounts are calculated based on the pre-1992 reform, i.e. based on income of the last 10 years of their career.
- Finally, for those that had less than 18 years of contributions in 1995, the pro-rata method is used: the pension is calculated via a weighted average between the old and the new methods.

Following in the footsteps of Sweden, Italy opted to adopt a notional defined contribution system. Under the new system, Italy introduced a new pensionable age and minimum contributory period. Moreover, in order to retire under the NDC pension system, an individual would be required to have a minimum of 5 years of contributions with at least 57 years old. Additionally, individuals with a contributory period of 40 years are also able to retire regardless of age. Ultimately, the aim of the reform is tighten the link between contributions and pensions. Individuals with less years of contributions would be entitled to a lower pension, hence providing a disincentive to retire early. In line with this objective, pensions are also actuarially adjusted according to the life expectancy table of 1990. The coefficients of adjustment are 4.72 and 6.136 for 57 and 65 years respectively.

The initial pension amount to be credited in the notional accounts is equivalent to the contributions paid in the previous year at a capitalization of a five year moving average of the nominal GDP growth rate. The initial benefit is calculated at rate of 33 percent that is age adjusted. Under the new regime, the minimum required contributory period to retire was lowered from the initial 15 years to only 5 years. Finally, the new system is financed via a contributory rate of 32.7 percent to be split between employers and employees. The contributory rate of the new system is set at 32.7 percent to be split between employers and employees

4.3. The Polish Experience

4.3.1. The pension system before the reform

In the year 1999, Poland underwent a dramatic change to its pension scheme. Afflicted by the same problems that face many other countries with a traditional PAYG-DB scheme, such as demographic and financial pressures, the Polish government decided it was necessary to undergo a structural change in its pension system and switched to a Notional Defined Contribution scheme(Góra, Rutkowski, & Rutkowski, 2000). The new pension system in Poland came into force on the 1st of January of 1999 as a replacement for its predecessor. The pre-reform pension system in Poland was fragmented and is consisted by three major subparts: the pension system for employees and self-employed; the pension system for farmers; and the pension system for the armed forces. The first two schemes are contributory while the latter is financed via general tax revenue.

Table 4 Pension Expenditure in Poland as a percentage of GDP, 1991-1995

	1991	**1992**	**1993**	**1994**	**1995**
Employee Pension Scheme	14	16.3	15.8	16.1	16.6
Farmers Pension Scheme	1.9	2.1	2.1	2.4	2.6
Armed Services Pension Scheme	1.6	2.2	2	2.1	2.3
Total	17.5	20.6	19.9	20.6	21.5

Source: Adapted from Crombrugghe (1997)

As shown in *Table 4*, total pension expenditure in Poland increased up to 21.5 percent in 1995 from 17.5 percent in 1991. Of the total pension expenditure, the most representative expense is from the Employee Pension Scheme, which increased from 14 percent in 1991 to 16.6 percent in 1995. The remaining expenditure is explained by the increase in the Farmers Pension Scheme (1.9 percent in 1991 to 2.6 percent in 1995) and the Armed Services Pension Scheme (1.6 percent in 1991 to 2.3 percent in 1995).

The employee pension scheme was administered by the Social Insurance Office (ZUS - Zaklad Ubezpieceń Spolecznych) and was financed by a contribution rate of 45 percent to be split between employees and their respective employers. Under this scheme there were different retirement conditions for both men and women. On the one hand, men could retire at the age of 65 provided they had contributed for social security for at least 25 years. On the other hand, women were allowed to retire with a full benefit at the age of 60 years old with at least 20 years of contributions. Additionally, there were special conditions concerning early retirement for specific professions. Women with at least 30 years of contributions could also withdraw a full pension benefit from the age of 55 years old.

In 1999, the formula used to calculate a pension benefit under the Employee Pension Scheme in Poland was:

$$P = 0.24w + (0.013T + 0.007N) \times eB$$

The base amount for the pension system was set at roughly 24 percent of average wage and is represented by the 0.24w section of the equation. The remainder of the pension was calculated based on the contributory career of the individual. First there was a 1.3 percent of referent earnings for each year of contributions. For example, an individual that worked for 30 years would receive the minimum guaranteed pension of 24% of average wage plus 39 percent of his or hers average of the best 3 of the last 12 years of earnings. The formula for the reference earnings was changed to the best 10 of the last 15 years of contributions in the year 2000. Additionally, the individual could accumulate an extra 7 percent for every non-contributory year. Finally, the pension had a ceiling of 100 percent of individual average earnings.

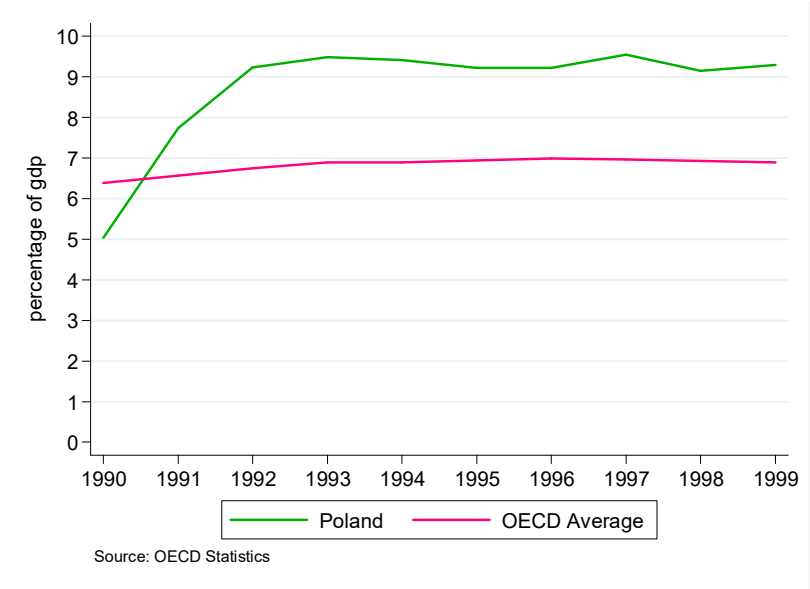
The Farmers Pension Scheme was created in 1978 and from 1991 it began to be administered by a separate branch, the Farmers Social Security Institution (KRUS). The system was designed to cover every farmer that owned more than 1 hectare of land and were not covered by a different scheme. The system was financed via a flat-rate contribution and pension amounts are not indexed to

individual earnings. Instead, they are based on the contributory period alone. Individuals with longer careers will have higher pension benefits.

4.3.2. Reasons for pension reform

According to the work of (Chlon-Dominczak, 2003), the need for pension reform in Poland resulted from the increases in pension expenditure that was experienced in the 1990s. As shown in *Figure 14,* there was an explosive increase in pension expenditure as a percentage of GDP in the early 1990s that stabilized around 1993. The figure shows that pension expenditure as a percentage of GDP in Poland rose from 5 percent in 1990 to over 9 percent in 1999, surpassing the OECD average as early as 1991.

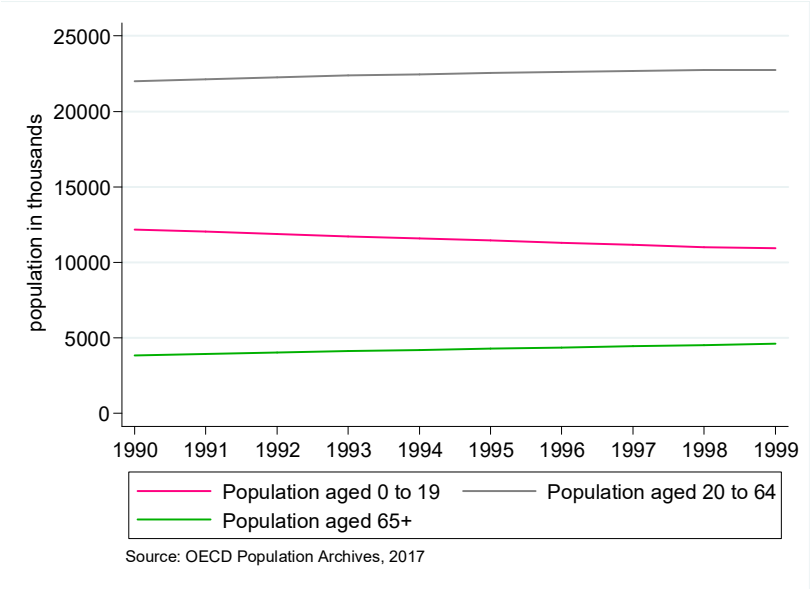
Figure 14 Comparison of Pension expenditure as a percentage of GDP between Poland and the OECD average, 1990-1999



Initially, financial pressures on the pension scheme were dealt by a systematic under-indexation and by allowing inflation to erode benefit levels, which eventually led to an increasingly inequitable pension system (World Bank, 1994b). In a working report for the World Bank, Alain de Crombrugghe (1997) studies the role that wages and pension pressures have played in the early 1990s Polish budget crisis. The author argues that in spite of the increase in wages and contributions, the additional revenue was insufficient to cover the increase in pension expenditure resulting from the increase in retirees. Additionally, an increase in the average level of income would eventually translate into an

increase in pension expenditure on the long-run. As individuals contributed at a higher rate, they would eventually collect a higher level of pension benefit. Although the increase in the number of pensioners was not as extreme as that experienced in Sweden, it was also accompanied by a decrease in the number of individuals aged 0 to 19 years old (*Figure 15*).

Figure 15 Population by age group in Poland, 1990-1999



According to Góra et al. (2000), while the pension system in Poland suffered from the traditional difficulties faced by most PAYG-DB schemes, there were a specific set of conditions that made it particularly inefficient. The authors argue that the additional rules and privileges added in the early 1980s and 1990s had a dire impact on the fiscal sustainability of the pension system and consequently led to a sharp increase on the levels of contributions in order to maintain the system. Among these, there were the very liberal conditions for retirement. In 1999, men were allowed to retire at the age of 65 with 25 years of social security contributions, while women were allowed to retire at the age of 60 with 20 years of contributions. Additionally, the system allows for several concessions for early leave schemes that favour particular interest groups. For instance, veterans, disabled individuals or women with 30 or more years of contribution could collect a pension pension at the age of 55 years old. According to a study by the World Bank (1994b) this eventually led to a drop in the overall age of retirement from 59 years in 1989 to 56.9 years in 1993.

On the revenue side of the pension system, there were additional problems. The overall increase in pension expenditure eventually led to an increase in the levels of contribution to the system from 25 percent in 1981 to a staggering 45 percent in 1999. According to Chlo-Domiczak and Góra (2004), the extremely high contribution rate of the Polish pension system was one of the main reasons for the pension reform in 1999. Additionally, between 1988 and 1993, Poland experienced an increase in the levels of unemployment from reaching almost 3 million unemployed individuals (Perraudin & Pujol, 1994). According to Perraudin & Pujol, 1994, the increase in unemployment in Poland provided a triple threat to the system: first, it generated a surge in early retirement; second, it reduced the contributory tax base; and third, the unemployed constitute another burden to the social security system. This meant that not only did the increase in unemployment produced an additional cost due to unemployment benefits, but also increased the number of pensioners due to the conversion of unemployment benefits into pension benefits and reduced the overall contributions to Social Security, since unemployed individuals were unable to contribute.

Finally, a World Bank (1994b) country study argues that as it stood, the Polish pension system presented an increased burden on the state budget without consistently meeting either the social insurance or redistributive objectives of a pension system. Eventually, all of the issues combined led to a heated debate on pension reform. According to Gorá and Rutkowski (2000), the debate on pension reform in Poland was divided along three different sets of opinions. First, there were those who argued that the system should remain as a PAYG. Dubbed by the authors as the "*rationalizers"*, these groups pressed for a parametric reform of the system with the objective of cutting back on its generosity. Second, there were the ones dubbed by the authors as the "*reformers*". These groups of individuals defended that there was a need for fundamental change in the nature of the Polish pension system. The aim was towards either a fully funded or a multi-pillar scheme. The third and, according to Gorá and Rutkowski (2000), most influential group, were the "*non-reformers"*, which defended that the system would not benefit from a large scale reform. Instead, the *non-reformers* defended that simple short-term preventive measures, such as under-indexation of pensions for example, would be

sufficient to assure the sustainability of the pension system. While the non-reformers took the spotlight during the late 1980s, by the 1992-93 they were nearly extinct.

Although the Polish government adopted some reforming measures from the *rationalizers'* side in 1995, they were soon deemed as insufficient and an alternative reform model was prepared, which suggested a full scale reform of the pension system into a three-pillar NDC pension system that would be adopted in 1999 as the new national pension system in Poland.

4.3.3. The new Pension System in Poland

The abolition of the previous PAYG-DB scheme in 1999 provided policymakers with a great opportunity to innovate in the designing of a brand new pension system. One of the primary focus of this reform was to create a pension scheme that was resilient against economic and demographic shocks as well as a transparent system that would be able to maintain its legitimacy (Chlon-Dominczak & Góra, 2006). The new Polish pension system is characterized by a multi-pillar arrangement that comprises a state run compulsory insurance system and a system of mandatory and voluntary individual retirement accounts. The underlying idea is that the diversification of pillars would provide additional layers of security against the common threats of the pension system, hence the name of the program for pension reform: "Security through diversity" (Hausner, 2002).

The original pension reform of 1999 consisted of two major changes in relation to the previous scheme: first, the traditional PAYG-DB system was virtually replaced by a Notional Accounts scheme; and second, the reform introduced a new partially funded capital pillar to the system (Hagemejer, Makarski, & Tyrowicz, 2015).

The First Pillar of the new Polish Pension System is very similar to the Swedish pension system. It is composed by a NDC scheme with a 12.22 percent contributory rate. During the transition, individuals that were born before the 1st of January of 1969 could choose between two pension options. They could either chose for a completely NDC scheme or for a combination between NDC and FDC. Additionally, for individuals that do not participate in the second pillar, will be applied a contributory

rate of 19.52 percent (12.22 NDC + 7.3 FDC) split equally between the employer and the employee. Just like in the Swedish NDC, the contributions made by the individuals are registered in their notional accounts that are administrated by the ZUS. Contributions have a ceiling rate of 250 percent of the national average wage. During the transition period, a procedure was designed to convert pension rights into account values. In essence, this procedure consisted in retiring everyone that was born after the 31st of December of 1948 by crediting them with an initial capital into their notional accounts. This initial amount was determined according to the old rules, i.e. their entitled pension if they were to retire at this time.

Contrary to the Swedish case, there is a differentiated age of retirement for men and women that was kept from the previous system at 65 and 60 years old respectively. However, while the minimum retirement age was kept from the previous system, the minimum contributory career was not. In the new system there is not a minimum contributory period for retirement. At the time of retirement, the size of the pension is determined by dividing the capital accumulated in the notional account by the average unisex life expectancy.

While the new Polish Pension system is characterized by three pillars, there is an extra tier of social protection that pertains to old age pensioners and that should be taken into account. The *zero* tier is a guaranteed minimum pension that is paid to every individual that has reached the statutory age of retirement and has accumulated pension credits over 20 years for women and 25 years for men. The guaranteed pension is a means-tested benefit and works in the same way as the Portuguese pension social complements, i.e. if pension income falls under the threshold it triggers the guaranteed pension that will contribute with an amount that equals the difference between the actual pension amount and the minimum guaranteed pension. This contribution is seen as a social complement, which means that it is financed via State budget.

On top of the first pillar, there is an FDC pension plan that constitutes the second pillar of the Polish Pension System. This pillar is mandatory for all employees that were born after 1999. Employees that

were born between 1949 and 1969 were given an irrevocable choice between joining the multi-pillar system and remaining in the old traditional PAYG scheme. Under the second pillar, employees transfer a portion of their social security contributions, 7.3 percent, to a fund of their choice that is managed by a pension fund society. According to Kowalewski (2008), of the 13 million individuals given the choice, 7 million chose to participate in the new FDC pillar of the Polish pension system.

Finally, the third pillar of the Polish pension system is based on a voluntary pension plans. These plans are aimed at adjusting pension income and benefit from specific tax privileges that make it advantageous for those who wish to participate. Contrary to the second pillar, the voluntary pension plans were deemed a failure by experts (Kowalewski, 2008). The Polish government even tried to expand this pillar by including individual accounts, however, both programs were considered a failure (Kowalewski, 2008).

4.4. The impact of the reforms: a cross country comparison between Sweden, Italy and Poland

4.4.1. The impact of the reforms

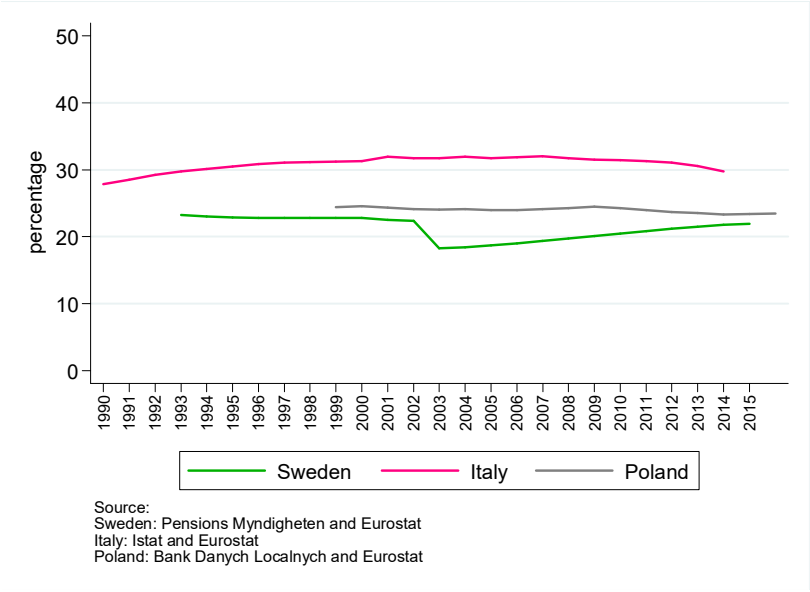
In this section, I will focus on the outcomes of the implementation of the new NDC pension schemes in the countries analysed above. This analysis will focus primarily on the objectives of a pension system. According to the analysis presented in chapter 1, the fundamental objective of a pension system is to reduce poverty among the elderly. Further, pension systems may have other objectives, such as consumption smoothing and redistribution. Overall, the primary goal of pension system should be to provide adequate, affordable and sustainably retirement income. As we have seen, that seems to be the trend between all of the pension reforms analysed above. As a result, this section will focus on assessing the impact of the pension reforms in Sweden, Italy and Poland along the lines of the objectives of a pension system. In order to achieve this goal it will look at three aspects of the pension system: coverage, financial sustainability and adequacy. Ideally, this analysis would be done with data before and after the pension reforms have taken place. However, in some cases I was unable to find

the relevant data for the period necessary. As a result, for some indicators it will not be possible to compare the old and the new pension systems. In these cases, it will only be possible to analyse the new pension since its introduction.

4.4.2. Coverage

Under the umbrella of coverage, we have the number of old age pension beneficiaries. Since the total population of each of the countries studied differs greatly from one another I have opted to look at the number of beneficiaries as a percentage of total population. This provides an easier plane for a cross-country analysis since it presents the results in relative terms rather than absolute numbers making it possible to directly compare the different regions.

Figure 16 Number of old age pensioners as a percentage of total population, 1990-2015

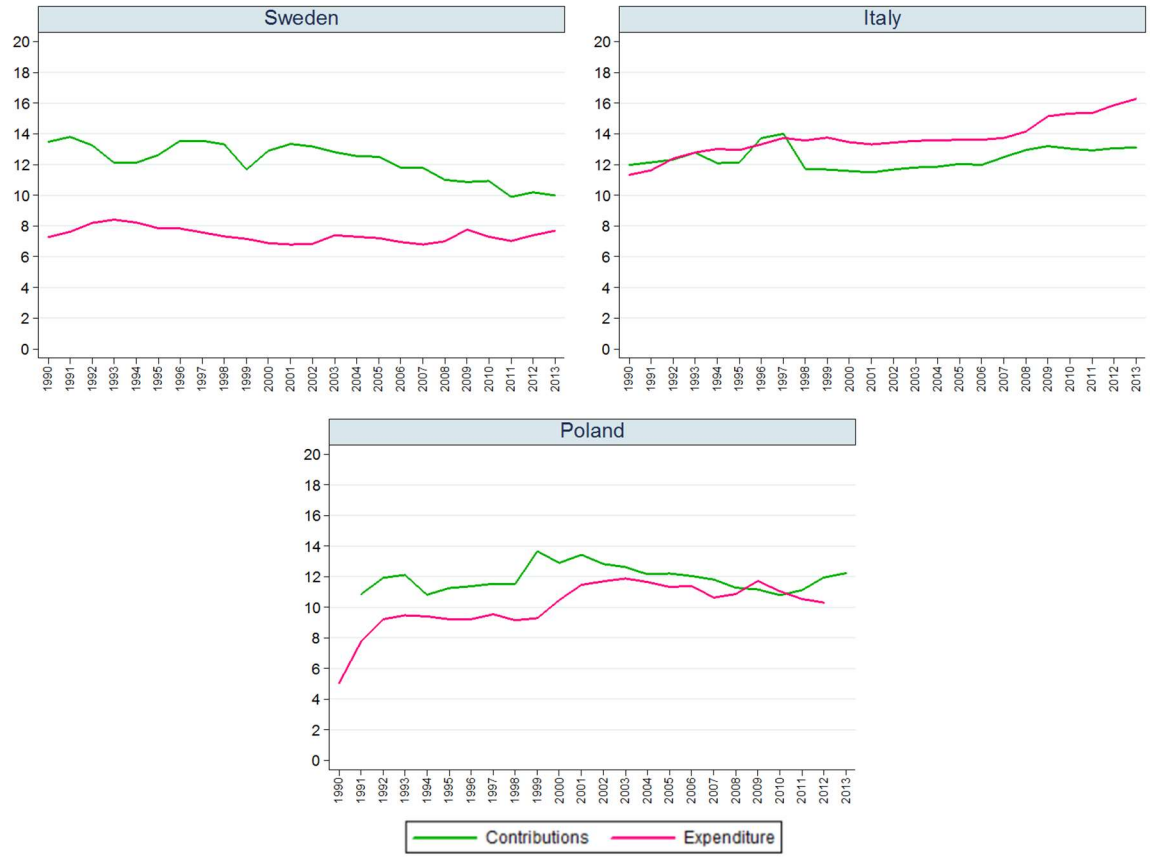


As seen in Figure 16, coverage is greatest in Italy, followed by Poland and finally Sweden. Although the number of beneficiaries is lower in Sweden, this does not mean that there are more people (in relative terms) that do not have a pension in Sweden than in Italy. It may simply mean that there the proportion of individuals aged 65 and over may be lower. Note that between 2002 and 2003 there was a great drop in the number of beneficiaries in Sweden.

4.4.3. Financial Sustainability

Figure 17 shows a cross-country comparison of pension expenditure and social security contributions as a percentage of GDP. Essentially, a conversion from a traditional PAYG-DB scheme to a NDC system would entail a closer link between contributions and expenditure. This means that we should expect a convergence between the two lines. This is evident in the cases of Sweden and Poland. However, not so much in Italy. This may be due to the way the transitions were implemented. In Poland and Sweden the transition was a lot faster than Italy and therefore it is expected to produce results a lot faster. Since the phase-in of the Italian pension reform is extremely long in comparison to the other two countries, results may only become evident in the future. In Italy, at least for the time being, it seems that the financial sustainability of the system remains weak, with expenditure as percentage of GDP surpassing contributions by a great deal. On the other hand, Sweden and Poland did not have a long phase-in period. This may be the reason for the closer link between contributions and pension expenditure.

Figure 17 Pension expenditure vs Social Security contributions as a percentage of GDP, 1990-2013



Source: OECD.Stat Website

By looking at the *Figure 17* it we can see that in Poland, expenditure surpassed contributions in 2009 and 2010. This may be a result of the Global Financial Crisis that took place in 2007-2008. In his work, Guardiancich (2013) finds in spite of the limited impact of the crisis on the Polish economy, its impact on the pension system was disastrous. Internal and external pressures eventually led to the detriment of the multi-pillar system and during the years following the financial crisis, the mandatory funded pillar was fundamentally used as a short-term solutions for the budgetary problems that Poland was facing at that time. In comparison, based on this data, the Swedish pension system appears to have dealt with the impacts of the global financial crisis fairly well.

4.4.4. Adequacy

The previous decades were an era characterized by transformations of the pension systems in Europe. The importance of fiscal sustainability of the pension systems came into the spotlight during the 1990s

with the publication of the World Banks report, Averting the Old Age Crisis in 1994. However, this report sparked not only interest for sustainability but also for adequacy of pension systems. The ever changing and intrinsic nature of our social context calls for a comprehensive social protection system that provides adequate protection while ensuring its very own fiscal sustainability.

While the primary objective of these reforms is to ensure the sustainability of the pension system, the impact of these reforms cannot be simply measured by an analysis of the fiscal sustainability of the system. By doing so, it would ignore the main objective of a pension system, which is to provide income security in old age (Barr, 2013). According to Barr (2013), this objective is divided into four elements: consumption smoothing, insurance, poverty relief and redistribution. In Portugal, the objective statement of the Social Security Institute clearly states that one of its objectives is to "promote the sustained improvement of the levels and conditions of social protection, as well as to reinforce equity" (Social Security Institute, 2018). As such, it appears that an analysis simply based on the fiscal sustainability of the system seems to fall short of an accurate evaluation of pension reform.

In this sense, it is clear to see that recent works on the impact of pension reforms are beginning to broaden their scope of analysis, going beyond the notion of improvement in its simplistic form of fiscal sustainability and converging towards a bigger consideration of adequacy – alongside sustainability – as a more effective way to analyse the impact of pension reform. This is made clear in the World Bank report on pension reform by Holzmann and Hinz (2006), where an adequate pension system is defined not solely with regards to their fiscal sustainability, but also as a system providing benefits "that are sufficient to prevent old-age poverty" as well as "reliable means to smooth lifetime consumption for the vast majority of the population" (Holzmann & Hinz, 2006). The first notion of adequacy identified by the authors refers to the ability of a system to prevent a situation of poverty, which can easily derive from a number of factors in an individuals' life, such as health factors or problematic working careers for example. This ensures the re-distributive aspect of social security that safeguards all individuals against poverty, even those that had a less fortunate life. The second notion of adequacy

identified by the authors refers to the ability of an individual to smooth the unavoidable drop in consumption associated with retirement. In a more simplistic and clear way, it refers to the ability of an individual to adequately save and prepare for the drop of income that comes with leaving the labour market. In this sense, an adequate retirement pension is one that ensures that an individual is able to maintain their consumption levels as close as possible to those he displayed prior to retirement.

Building on the notion of adequacy put forward by Holzmann and Hinz (2006), Borella and Fornero (2009) add a third notion of adequacy that refers to the comparison of living standards between retirees and the active population. In their work, the authors introduce the income replacement rate as a way to measure pension adequacy which has quickly gained memento in the literature regarding pension reform impact. In general, replacement rate refers to the percentage of pre-retirement income that is currently paid as a retirement pension. This provides a very good analysis of the loss in income associated with retirement from the labour market. A quick analysis of the empirical research on pension adequacy reveals that the majority of the literature focusses solely on a single dimension: replacement rate.

Despite the popularity of this measure, authors such as Chybalski and Marcinkiewicz (2016) argue that, while an important measure of adequacy, the replacement rate is limited to measure a sole aspect of adequacy – income and consumption smoothing. Instead, the authors recognize the benefits of complementing the replacement rate with additional measures, such as the level of spending among pensioners or their households for analysing consumption. As a result, this section will attempt to apply a multi-dimensional approach to assessing the adequacy of the pension systems after the pension reforms. For this purpose, it will look at two dimensions of pension adequacy: pensioner poverty and inequality.

4.4.4.1. First Dimension: relative income situation of the elderly

Pension systems are a key factor in ensuring that older individuals are able to maintain their living standards post-retirement. In line with this objective, this section will first analyse the current income situation of elderly individuals followed by the role pension systems have in income maintenance. For the purpose of this assessment, the relative median income ratio and the aggregate replacement ratio will be used.

The relative median income is a pertinent measure for the analysis of the overall income situation of the elderly (65+ years old) in relation to the working population (15-64 years old). Due to its relative nature, this indicator can vary based on two factors: first there is the aspect of pension generosity. If the pension system becomes more generous with all other factors remaining the same, namely labour market wages, the relative situation of older people in relation to the younger population will improve. Second, there is the earnings level of the working generation. By being a relative indicator of wealth, the median relative income of elderly people is sensitive to changes in the earnings of the working population. For example, if the median earnings of the working population decrease and the pension levels remain equal, the relative situation of the elderly will improve.

Table 5 Median Relative Income of the Elderly, 2004-2014

Coutry	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Italy	0.88	0.85	0.87	0.86	0.88	0.89	0.92	0.92	0.96	0.97	0.99
Portugal	0.76	0.77	0.79	0.8	0.83	0.85	0.82	0.87	0.92	0.94	0.94
Sweden	0.79	0.81	0.85	0.81	0.78	0.77	0.79	0.77	0.78	0.81	0.83
EU27	.	0.86	0.85	0.84	0.85	0.87	0.88	0.9	0.92	0.93	0.94

Source: Eurostat data based calculated from EU-SILC

Table 5 displays the relative median income figures for Italy, Norway, Poland, Portugal, Sweden and the EU27. A quick analysis of this table shows that the relative median income of the elderly in the EU-27 has slowly increased between 2004 and 2014 from 86 per cent to 94 per cent. With the exception of Sweden at 83 per cent, in 2014 all countries display a median relative income very close to the EU27 average, with Poland and Italy in the lead with 99%. This shows that in relative terms, the Pension

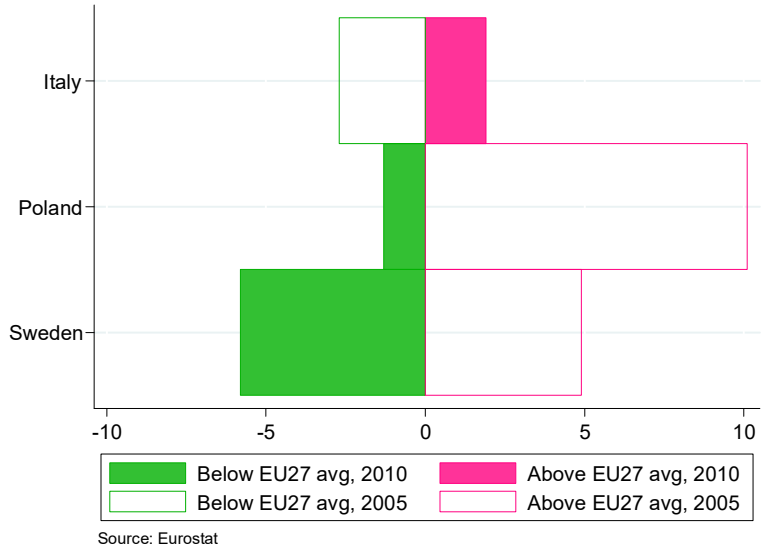
systems of Italy and Poland are more generous than that of Sweden. It is important to note that in Sweden the values have fluctuated, increasing and decreasing over time but never displaying a significant change. Once again, it is important to note that a decrease in this figure does not necessarily mean a decline in the living conditions of the elderly. Instead, it could very well be a result of an increase in the earning levels of the working population. Therefore, it is important to analyse this indicator in parallel with other absolute variables that can provide us with a much more clear idea of the reasons behind these fluctuations.

4.4.4.2. Second Dimension: poverty among retirees

One of the main objectives of a Social Protection system is to reduce poverty and inequality among the elderly. For the purpose of analysing poverty among retirees in the newly reformed pension systems, this section will use two indicators. First, in order to determine the number of individuals at risk, it will look at the at-risk-of-poverty rate (*arop*) for the elderly. Second, in order to analyse the redistributive impact of the pension system, it will look at the inequality between pensioners and individuals in active age before and after transfers.

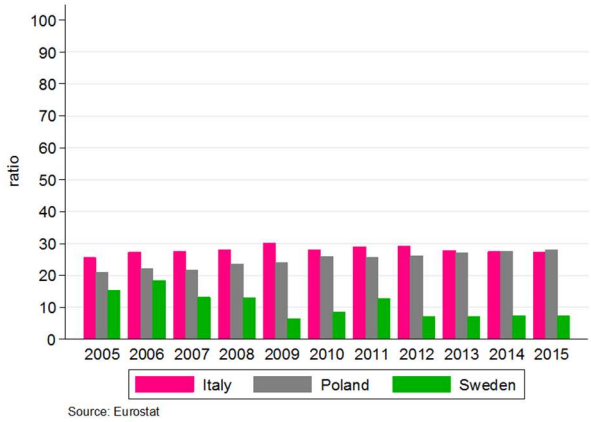
Figure 18, displays the evolution of the *arop* of individuals aged 65 and over between 2005 and 2010 in reference to the EU 27 average. As shown, the poverty rate in Italy has increased during the period in question, surpassing the EU27 average. On the other hand, Poland and Sweden had a significant increase in terms of their *arop* of the elderly. As seen, rate of individuals aged 65 and over at risk of poverty has fallen well below the EU27 average in Sweden. Although the figure in Poland is closer to the EU27 average than in Sweden, Poland has experience a greater percentage exchange than Sweden. Once again, we see the countries that had a faster implementation of the NDC system outperforming Italy.

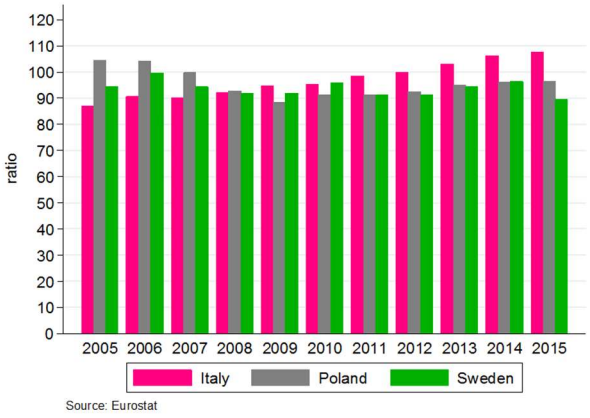
Figure 18 At-risk-of-poverty Rate for individuals aged 65 and over in relation to the EU Average, 2005-2010



Finally, as shown in *Figure 19*, the benefit ratio for old age pensioners before (left) and after (right) transfers clearly demonstrates the impact that social transfers have on the average income level of the older persons. An interesting point is that in some cases, the benefit ratio actually goes over 100, which in turn means that the average pension amount is actually superior to the average wage of individuals in active age. It is noteworthy that this type of relationship never happens in Sweden, which has implemented an Automatic Balance Mechanism that keeps the generosity of the pension system in check in according to the system's ability to cover its obligations. Additionally, the impact of the Automatic Balance Mechanism is clear in 2008 and 2009, which show the lowest levels of benefit ratios in Sweden. Clearly a response to the poor development of the economic associated with the Global Financial Crisis that affected the majority of countries during this period.

Figure 19 Benefit Ratio before and after social transfers





Chapter 5: Methodology

5.1. Introduction

This thesis has been developed in an attempt to answer a broad question: *what would be the impact of the introduction of a Notional Defined Contribution old age Pension System on the financial and social sustainability in Portugal*? In order to achieve this, 4 sub-questions were developed in order to breakdown this exercise into smaller parts. Consequently, each sub-question has led to a hypothesis that was tested in the previous chapters of this thesis. The questions and respective hypothesis of this thesis were the following:

1. Does the current Pension System in Portugal have a risk of financial instability due to exogenous factors such as demographic ageing?

   H_1: The process of demographic ageing does not pose any threat to the sustainability of the current Pension System in Portugal.

2. Would a transition to a Notional Defined Contribution Pension System improve the financial sustainability of the pension system?

   H_2: A transition to a Notional Defined Contribution System would significantly improve the financial sustainability of the Pension System in Portugal.

3. What would be the impact of a transition to a Notional defined Contribution scheme on the social sustainability and the adequacy of the pension system?

   H_3: A transition to a Notional Defined Contribution System would worsen the adequacy and the social sustainability of the Pension System in Portugal.

4. Would a Notional Defined Contribution Scheme be better to ensure sustainability in light of exogenous factors, such as demographic ageing or slow economic growth, than the current Pension System in Portugal?

   H_4: A transition to a Notional Defined Contribution System would ensure that demographic ageing and slow economic growth have no impact on the sustainability of the Pension System in Portugal.

In order to answer this question, the method chosen to gather data was to develop the transition to a NDC pension system through a Dynamic Microsimulation Model and to analyse the results comparatively. The remainder of this chapter will provide an overview of the DYNAPOR model that was used to simulate this transition. Finally, the last section of this chapter puts forward a NDC model for the Portuguese context and explains it thoroughly.

5.2. Description of the Model

DYNAPOR is a Dynamic Microsimulation model of the Portuguese Social Security System that was developed from the MIDAS_BE[9]. The model is designed using the LIAM2 platform and allows the users to perform reliable simulations of the demand for the most relevant benefit schemes in Portugal for the period between 2014 and 2060. Aside from modelling the demand for social protection, DYNAPOR is also able to simulate the future development of the major sources of funding for the Portuguese Social Security System (Social Security contributions), thus providing a valuable platform for the analysis of the long term sustainability of the pension system in Portugal. Additionally, the since the simulation is done at the micro-level, i.e. the individual level, the DYNAPOR model allows to simulate the impact, and the distributive effects of policy reform proposals, as well as difference macroeconomic and demographic scenarios.

5.2.1. Design and Architecture of the Model

DYNAPOR is a cross-sectional Dynamic Microsimulation Model that runs on a random cross-sectional sample of the Portuguese population that was extracted from the 2013 European Union Statistics on Income and Living Conditions Survey (EU-SILC). The model is designed to follow a closed population approach. This means that the model preserves all the individuals in the dataset – expect for new-borns and the deceased. In DYNAPOR, individual changes over time are simulated through a discrete-time modelling approach. This means that for each simulation period, the probability that a given event takes place (death, unemployment, retirement, etc.) is estimated for every individual in our

[9] MIDAS is a Dynamic Microsimulation Model that was developed by the Federal Planning Bureau in Belgium (Dekkers, Inagaki, & Desmet, 2012).

dataset. The assignment of an event to a give individual in the sample is done through one of the following mechanisms:

- *Deterministic Behavioural Equations.* An individual is assigned to experience an event by whether or not he or she complies with a set of conditions that determine eligibility for said event. This is typically used to simulate the take-up of Social Security benefits or the application of social security contribution or tax rules.
- *Probabilistic Behavioural Equations.* An individual behaviour is assigned according to a set of predictors. This is essentially used to simulate the number of worked hours and changes in wages.
- *Alignment Process.* The alignment procedures in DYNAPOR uses the "alignment by sorting" technique described in Li and O 'donoghue (2013). According to this type of procedure, individuals are ordered in descending order according to the risk of a given event taking place. The risk is often estimated in the form of a score through either a regression model or, in some cases, an ad-hoc score selection. Finally, based on a table of external aggregate data, the number of individuals with the highest probability for the event to take place are selected according to the percentage determined by the relation between tables[10]. This is typically used to simulate the likelihood of demographic and labour market events.

[10] The use of the alignment process to assign events to the individuals in the model allows us to keep the probabilistic nature of the model, whilst guaranteeing that the results of the model are always aligned with external aggregate variables – which helps to guarantee the (external) validity of the outcomes of the model.

Figure 20 General Architecture of the DYNAPOR model

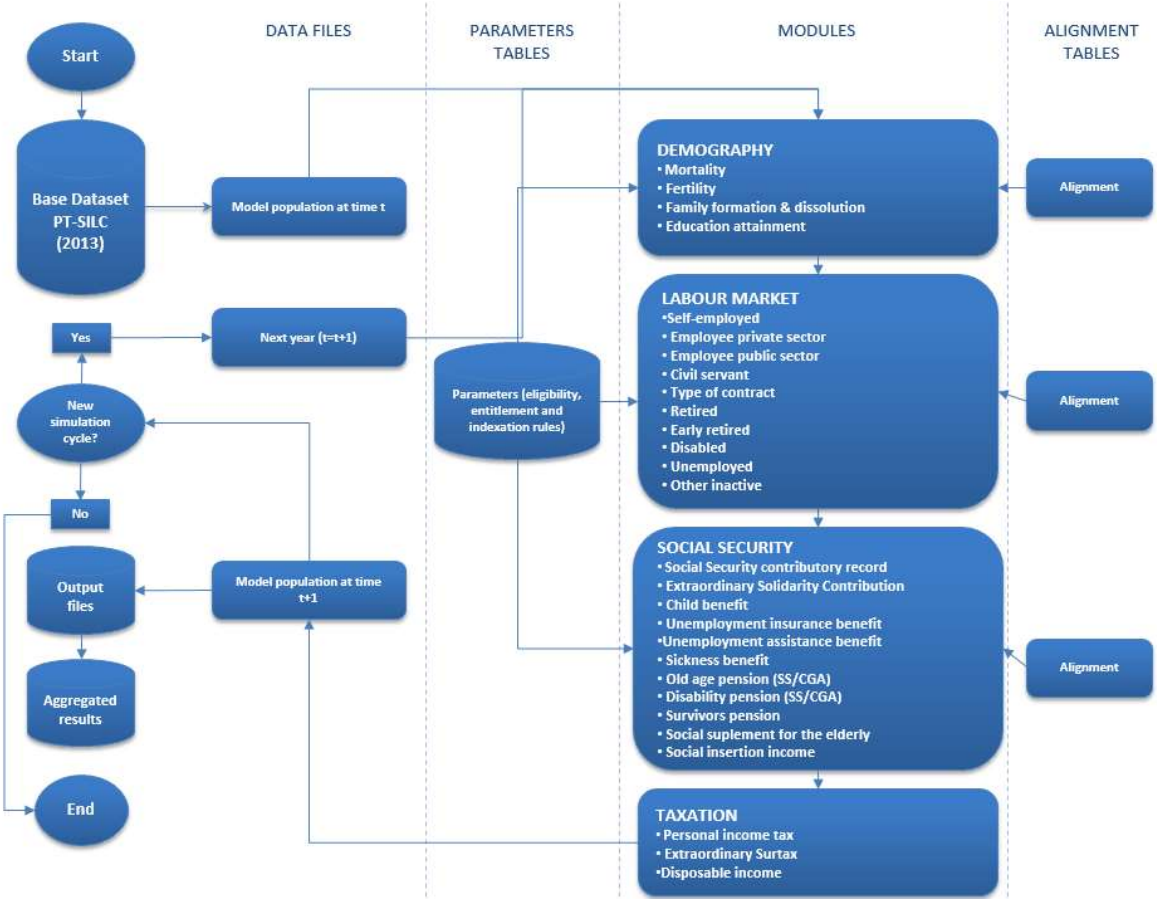


Figure 20 presents the general architecture and operational routine of DYNAPOR. The flowchart describes how the individual attributes of each individual is determined in each simulation period. First, each run starts by simulating the likelihood that each individual will face the most relevant demographic evens, such as, death, having a child, family formation/dissolution or education. After the demographic events, the model assigns the labour market status of individuals. The model currently assumes 9 different labour market status: private-employee, public-employee, civil-servant, self-employed, unemployed, retired, disabled, student or otherwise inactive. A quick representation of the labour market model can be found in Annex VI. As shown in the figure, first the total population is split into working and not working. This split is made according to the proportions found in the alignment tables. For the individuals that were selected for employment, the model computes the number of worked hours and gross earnings from work for each individual according to their personal characteristics.

After the earnings process, the simulation proceeds to the Social Security block. The first step in this section is to update the Social Security contributions of the individuals that are actively participating in the labour market. Then, the eligibility of individuals for each of the benefits covered by the model is simulated. If the individual is deemed eligible for a benefit, the benefit amount is calculated. Some parameters, such as the minimum pension amount for example, are stored in the form of a parameter table. The advantage of having a parameters table that contains information pertaining pre-established parameters, such as pension amounts that are determined via legislation for example, is that it allows the user to easily develop different scenarios. The final section of a simulation run is the taxation block. In this section, the model computes the income tax liability and determines both gross and disposable income. Consequently, this section allows for the determination of other indicators, such as poverty lines for example.

At the end of each run, the model produces an output file that registers the attributes for each individual in the base dataset, for that year. Subsequent cycles use this file as an input until the simulation period reaches its term. The set of output files with individual information can then be used to generate aggregate information for analysis purposes.

5.2.2. Base Dataset

The DYNAPOR model uses the 2013 EU-SILC survey as its base dataset. This dataset is comprised by a population of 16 410 individuals and 6 491 households. The EU-SILC is a representative survey of the Portuguese population that is carried out on a yearly basis since 2004. Additionally, the EU-SILC provides a reliable source of information, both at the household and individual level, on demographics, education, and health and income matters. The development of the initial dataset for the DYNAPOR model is split into five distinct processes that are described in the following subsections.

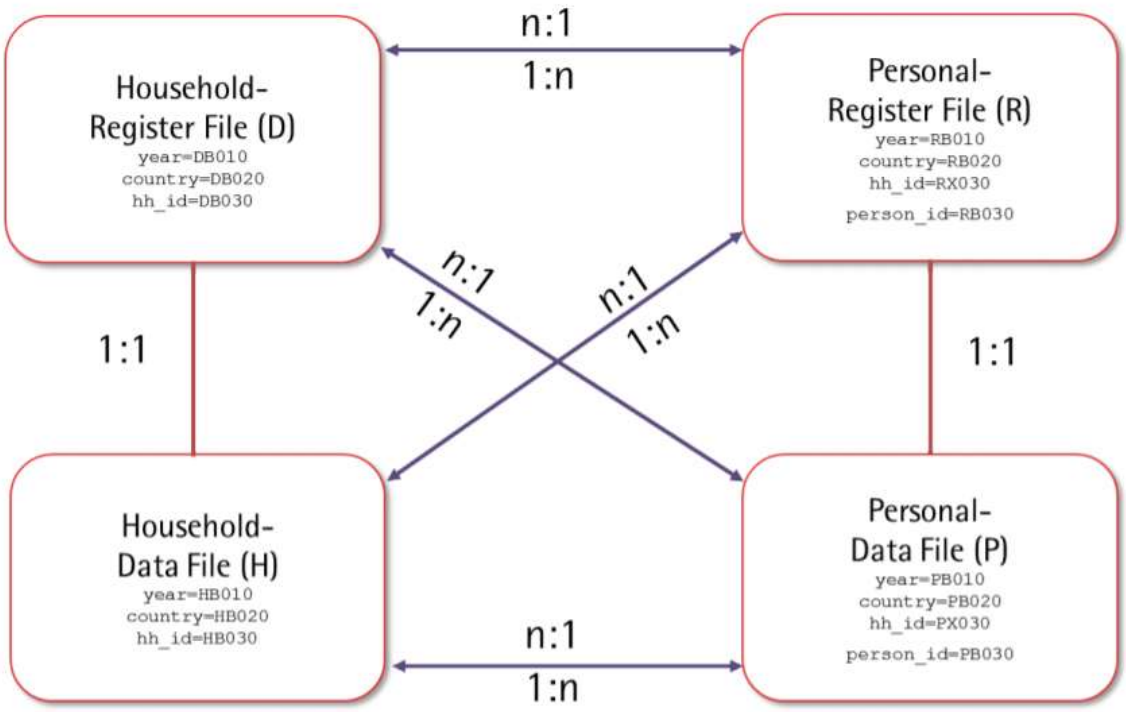
5.2.2.1. Merger of EU-SILC data

The construction of the base dataset, which serves as the starting point to our simulation, starts with the merger of the EU-SILC data. The EU-SILC cross-sectional data is provided to researcher in four different files that are letter coded as follows:

- Household Register (d-file): includes information on weights, sampling, regional identifies and degree of urbanization. This file contains information at the household level.
- Household Data (h-file): includes information on the interview, household income, subjective economic situation, household level poverty and employment indicators as well as information on household assets and housing.
- Personal Register (r-file): this is the only file that contains information regarding individuals aged 16 years or less. It mainly contains identifiers that can be used to analyse family relations, basic demographic information or variables on childcare usage. All variables are collected at the individual level.
- Personal Data (p-file): this is the largest of all the files and contains information at the individual level. However, no information for individuals aged 16 or less years old is included in this file. Moreover, it includes information on demographics, income, work, unemployment, health, nationality, migration, and work intensity as well as identifiers and information on the interview. Additionally, this file contains individual weights which allow us to expand our population in order to obtain results that are proportional to the size of the Portuguese population.

Since all of this data is separated, the first section of the construction of the database merges all of these files together. As explained in Mack (2016), the EU-SILC data is structured hierarchically, with individuals nested in households. In individual files, each individual is assigned a unique identifier as well as a household id. However, as noted by Mack (2016), each of the files described above has different names for each of the variables on identification and household id. As such, in order to merge the dataset, it is necessary to first proceed to harmonize the variable names. After this process is complete, it is possible to proceed with the merger of the files. Since several individuals can live in the same household, when merging the household level data into the individual level data it is necessary to use a many-to-one type of merge. The following schematic shows the types of merger that should be used when merging each of the files described above:

Figure 21 EU-SILC Merging Schematic



5.2.2.2. Recoding

The following procedure was to recode the variables. As the name of the procedure suggests, using the EU-SILC 2013 variables, I recoded and computed derived variables in order to, on the one hand, match the DYNAPOR code and, on the other hand, generate the input variables to model the Portuguese Social Security System. For instance, an important part of this exercise involved to ensure the compatibility between individuals' labour market status and they reported income source.

5.2.2.3. Data Imputation

Unfortunately, not all necessary variables to run the DYNAPOR model are available in the EU-SILC. Consequently, a series of data imputation procedures were employed with the purpose of including the necessary data to be able to produce the necessary dataset for the simulation. The imputations made were as follows:

- **Contributory careers -** With the help of administrative data, we were able to input data regarding the contributory careers of all individuals in the base dataset. The data that was supplied to us by GEP and information regarding contributory careers were displayed by

gender, work-status, age and earning decile. The ages ranged from 15 to 75 years old and the work status were wage earner, self-employed and unemployed. Due to the missing information for the remaining work-status in the model, we imputed the contributory careers of the unemployed to disabled and other inactive individuals. This allowed us to compute the necessary contributory careers for all individuals in the dataset with the exception of those in education or retired.

- **Ages 80+ -** Since the age variable in ICOR has an open group of 80 plus, in order to create a more realistic group of seniors we decided to input the ages of all individuals aged 80+. The imputation was done via a uniform distribution taking into account the percentage of individuals in each singular age by gender observed in the 2011 Census. In order to ensure that we remained with all the necessary individuals to input the age in the highest ages (those that usually have a lower percentage of individuals) we began to input the values for the oldest individuals first, with 100 years old, and worked our way to the 80 year olds.
- **Education level -** After some careful analysis, we have realised that some of the reported education levels were incompatible with the reported age, for example, some individuals reported having high education level and their age was lower than the necessary age to be able to achieve a high education level. As a result, we decided to input a new work-status for these individuals and re-assigned them to be in education. After altering work-status, we are always forced to re-recode the entire dataset in order to clean the variables that the new work-status is able to access, for example, in our model individuals are unable to work and be in education, as a result, it makes no sense for an individual to be in education and receive earnings from work.
- **Duration of unemployment benefit -** In order to determine the leftover duration of unemployment benefit we used the imputed contributory career and reference earnings in order to determine the original duration that the individual would be eligible to collect. Finally, since the variable duration in unemployment in EU-SILC limits the answer to 12 months, we

subtracted the reported months from our calculation and imputed the future duration of unemployment benefit to all individuals collecting unemployment.

5.2.2.4. Data Splits

Another important task that was necessary in order to construct the base dataset was to split some aggregate variables. For instances, the EU-SILC variable for old age pensioner does not distinguish whether the individual is covered under the General Scheme of Social Security or the CGA. Consequently, the variables in EU-SILC that contained aggregate data regarding two or more types of benefits or beneficiaries of the elements that are being modelled in DYNAPOR were split. The splits performed in the elaboration of the base dataset were as follows:

- **Unemployment Insurance beneficiaries vs. Unemployment Assistance beneficiaries -** Since the variable unemployment in EU-SILC is undifferentiated regarding type of unemployment, we opted by splitting the beneficiaries according to the verified proportions found in the administrative data, in 2013. This split was done using a uniform distribution technique that takes into account age-group.
- **Social Security Pensioners vs. CGA Old Age Pensioners -** The EU-SILC variable used to determine old age pensions was PY100G. Unfortunately, this variable contains information regarding old age pensions for all schemes and different pension arrangements and does not discern between Social Security Pensioners and CGA Pensioners we opted to apply a split. After a first comparison against administrative data, we found that there is a 10% underrepresentation the total number of pensioners (SS and CGA) in EU-SILC. As a result, we decided to distribute this error among all the pensioner schemes (SS old-age pensioners, SS old-age pensioners by long-term unemployment, SS social pension, SS early retired pensioners, CGA old-age pensioners and CGA early retired pensioners). Essentially, this split was divided into 4 different procedures:

1. *CGA and SS separation* - Following the administrative data, we employed a uniform distribution technique by choosing an amount for each scheme that was underrepresented by 10%;
2. *Social Pension Beneficiaries* - From those that were classified as Social Security Pensioners we split those that receive a Social Security Social Pension. We kept the 10% underrepresentation. This split was done by determining eligibility and adjusting the value margin in order to achieve the necessary number of social pension beneficiaries;
3. *Early Retired by Long-term Unemployment* - From those that were classified as Social Security Pensioners and have age lower than statutory retirement age (65 years old) we selected the necessary number of early retirees due to long-term unemployment according to administrative data and maintaining the 10% underrepresentation calculated in the early splits. In order to achieve this result, we employed a uniform distribution technique similar to the one used in the CGA and SS separation. This left us with two different groups, those that are early retired due to long-term unemployment and those that are early retired by choice. At the end of this split we had all of the Social Security Pensioners.
4. *CGA early retired pensioners* - For the early retired pensioners of the CGA we did not have the total necessary pensioners, even when considering the underrepresentation of 10% in the total number of pensioners. As a result, all individuals receiving a CGA pension and aged under statutory age of retirement were classified as early retired.

- **Social Security Pensioners and CGA Survivors Pensioners -** After an initial check, we determined that there is an underrepresentation of 28.5% in the total number of Survivors Pensioners (SS and CGA) in EU-SILC when compared with administrative data. As a result, we

distributed this error between Social Security and CGA Survivors Pensioners in order to minimize its impact on both schemes. The split was done by employing a uniform distribution.

- **Child Benefit Beneficiaries -** EU-SILC variable HY050G contains information regarding two benefits: child benefit and other family benefit allowances. In order to split this variable, we determined the families that were eligible to receive child benefit and attributed the value of HY050G to those families. This is the same method employed by EUROMOD.

5.2.2.5. Re-weighing of the dataset

There is a structural issue in the EU-SILC that pertains to the weight distribution used in the dataset. According to the EU-SILC 2013, the total weighed population is 10 487 289 individuals. Since the alignment of the DYNAPOR simulation uses the AWG projections as a reference for the population, the difference between the EU-SILC and the AWG becomes problematic. The population in the AWG data in 2013 is 10 455 316 individuals, a difference of 31 973 persons. One of the options to circumvent this problem could be to simply change the weight for a few individuals in the EU-SILC until we achieved the same number of individuals as the AWG (2015) projections. However, this option was eliminated as it would tamper with the distributions of the EU-SILC data. Consequently, the remaining option was to decrease the weight, at the same degree, to all individuals. The EU-SILC is composed by 16 410 cases. In order to achieve the necessary number of 10 455 316 we subtracted 1.948385131 from the individual weight of each individual (31973 / 16410), which allowed us to replicate the total population in AWG 2013 projections.

5.2.3. Dataset analysis

In order to assess the reliability of the base dataset after the imputations and the data splitting procedures, I have employed a comparative exercise between the aggregate information of the dataset and the available administrative and survey data. Table 6 summarises the coverage ratios for the old-age and survivors pensions in terms of beneficiaries and expenditure. Regarding old age pensions, the base dataset of DYNAPOR covers 88 percent of the number of beneficiaries and 95

percent in terms of expenditure. For survivors pensions, the coverage ratios are even smaller, with 72 percent for number of pensioners and 77 percent of expenditure.

Table 6 DYNAPOR base dataset and administrative data, Old-age and Survivors pensioners and expenditure in Portugal, 2013

Indicator	Base Dataset	Adm. Data*	Coverage
Old-age pensions			
Beneficiaries (number)	2 298 823	2 613 149	0.88
Expenditure (euros)	19 347 544 064	20 429 261 636	0.95
Survivors' pensions			
Beneficiaries (number)	588 692	822 950	0.72
Expenditure (euros)	2 113 046 016	2 761 494 136	0.77

* Calculated by adding up the information from the sources of tables 2 and 3.

In table 7, we assess the coverage of the DYNAPOR base dataset regarding the contributory pensions of the Social Security system (old-age by type, survivors and disability). Overall, the coverage of the DYNAPOR base dataset can be considered adequate, sitting above 85 percent. The exceptions concern the expenditure on early old-age retirement due to long term unemployment at 63 percent, the number of survivors pensioners at 72 percent and the disability pensioners and expenditure at 38 and 41 percent respectively.

Table 7 DYNAPOR base dataset and administrative data, Old-age, Survivors and Disability Pensioners and Expenditure, Social Security, 2013

Indicator	Base Dataset	Adm. Data	Coverage
Old Age Pension			
Beneficiaries (number)	1 704 021	1 939 000 (a)	0.88
Expenditure (euros)	10 903 276 544	12 080 462 900 (b)	0.9
Early retirement - Flexibility			
Beneficiaries (number)	66 029	75 000 (c)	0.88
Expenditure (euros)	408 278 464	650 883 750 (d)	0.63
Early retirement - Long-Term Unemployment			
Beneficiaries (number)	68 615	78 000 (e)	0.88
Expenditure (euros)	589 337 216	676 919 100 (f)	0.87
Social Old Age Pension			
Beneficiaries (number)	43 527	50 000 (g)	0.87

Expenditure (euros)	143 674 944	162 827 000 (h)	0.88
Survivors' Pension			
Beneficiaries (number)	498 364	697 000 (i)	0.72
Expenditure (euros)	1 829 144 704	1 897 317 000 (j)	0.96
Incapacity Pension			
Beneficiaries (number)	84 229	219 000 (l)	0.38
Expenditure (euros)	380 360 032	936 183 400 (m)	0.41

a) Source: Subtracted early retired and early retired due to long term unemployment from the number of pensioners in Conta da Segurança Social 2015, part II, pp. 251.
b) Source: Conta da Segurança Social 2015, part II, pp. 263.
c) Source: Own calculations based on Conta da Segurança Social 2015, part II.
d) Source: estimate based on average expenditure for Solidarity Subsystem.
e) Source: Conta da Segurança Social 2015, part II, pp. 262.
f) Source: Conta da Segurança Social 2015, part II, pp. 263.
g) Source: Conta da Segurança Social 2015, part II, pp. 255.
h) Source: estimate expenditure based on number of beneficiaries and higher social old age pension amount.
i) Source: Conta da Segurança Social 2015, part II, pp. 255.
j) Source: Conta da Segurança Social 2015, part II, pp. 265.
l) Source: Conta da Segurança Social 2015, part II, pp. 255.
m) Source: Conta da Segurança Social 2015, part II, pp. 263 and 265.

Finally, regarding the reliability of the base dataset used to run DYNAPOR in terms of representation of the CGA sub-system, *Table 8*, shows a coverage ratio of approximately 90 percent for old age pensions in both beneficiaries and expenditure. Regarding the survivors' pension, there is an underrepresentation in the DYNAPOR base dataset in the number of beneficiaries (72 percent) in the same order of magnitude that the one observed in the Social Security system. In the expenditure, the DYNAPOR base dataset fails to reproduce the administrative data (33 percent).

Table 8 Dynapor base dataset and administrative data, old-age and survivors pensioners and expenditure, CGA, 2013

	Base Dataset	**Adm. Data**	**Coverage**
Old Age Pension			
Beneficiaries (number)	416629	471 149 (n)	0.88
Expenditure (euros)	7302975488	8 348 798 736 (o)	0.87
Old Age Pension (aged 65+)			
Beneficiaries (number)	299125	337 342 (p)	0.89
Expenditure (euros)	5106050560	n/a	
Early retirement (aged <65)			
Beneficiaries (number)	117503	133 807 (q)	0.88
Expenditure (euros)	2196925440	n/a	
Survivors' Pension			
Beneficiaries (number)	90328	125 950 (r)	0.72
Expenditure (euros)	283901312	864 177 136 (s)	0.33

n) Source: CGA, Relatório de Contas da CGA 2013, pp.24.
o) Source: CGA, Relatório de Contas da CGA 2013, pp.35.
p) Source: CGA, Relatório de Contas da CGA 2013, pp.24.

q) Source: CGA, Relatório de Contas da CGA 2013, pp.24.
r) Source: CGA, Relatório de Contas da CGA 2013, pp.31.
s) Source: CGA, Relatório de Contas da CGA 2013, pp.35.

Finally, *Table 9* shows the assessment of the data in the base dataset on hours worked and earnings or in DYNAPOR first simulation year, depending on the year of the administrative data. The validation exercise shows that the hours worked in the base dataset, both for part-time and full-time workers can reproduce reasonably the available administrative data (109 and 100 percent respectively). With regards to gross earnings per hour and per year, the first simulation year in DYNAPOR shows a coverage ratio that is lower than the administrative data. It is important to note that at no point does the DYNAPOR coverage drop below 80 percent on this point.

Table 9 DYNAPOR Base Dataset and Administrative Data, Earnings and Hours worked, 2013-14

Indicator	Base Dataset (2013)	DYNAPOR (2014)	Adm. Data	Coverage (Base Dataset / Adm. Data)
Average hours worked per week				
Part-time	18.1	n/a	16.6 (t)	1.09
Full-time	42.487	n/a	42.7 (u)	1
Gross average earnings per hour (euros)				
Male	7.235	7.17	8.08 (v)	0.89
Female	6.369	6.46	6.88 (v)	0.94
Total	6.811	6.81	7.45 (v)	0.91
Gross Average earnings per year (euros)				
Male	15483	16082	19608 (x)	0.82
Female	12557	13134	15678 (x)	0.84
Total	14052	14609	17297 (x)	0.84

t) Source: Eurostat, LFS 2013 series (tps00072).
u) Source: Eurostat, LFS 2013 series (tps00071).
v) Source: Eurostat, SES 2014 series (earn_ses14_12).
x) Source: Eurostat, SES 2014 series (earn_ses14_26).

5.2.4. Underlying Assumptions

This section describes the key demographic, macro-economic and policy assumptions that guide this thesis in its quest for the analysis of the financial and social sustainability of the Portuguese Pension

System in a transition to a Notional Defined Contribution model. Additionally, it specifies if (and how) they are in line with the assumptions that underpin the 2015 Ageing Report projections.[11]

5.2.4.1. Assumptions about Demographic Dynamics

Traditionally, population projections are determined by three key demographic determinants: the number of children that are expected to be born each year (fertility rate), the number of persons that are expected to die (mortality rate) and the balance between people entering and leaving the country (net migration). However, given important gaps in the information needed to model migration flows[12], the population projections presented here are based on the assumption that there will be no migration flows (both inwards and outwards). This is the same as saying that the population dynamics will only reflect the natural growth dynamics (i.e., the balance between births and deaths) and that net migration will be equal to 0.

Table 10 Assumptions regarding the Demographic Dynamics

	DYNAPOR Baseline Assumptions	**Comparability with 2015 Ageing Report**
Fertility	• Fertility rates are expected to converge with 'forerunners' in demographic transition.	In line with 2015 Ageing Report a
Life Expectancy	• Mortality rates are expected to converge with 'forerunners' in demographic transition • Gains in life expectancy of men will be higher than that of women	In line with 2015 Ageing Report b
Migration	• No migration flows.	Not in line with 2015 Ageing Report c
Family Formation	• Individuals under the age of 16 are single.	Not specified

[a] In addition to this, we assume that there are no foetal deaths and that there are no twin births.
[b] European Commission (2014).
[c] European Commission (2014).
[d] In the 2015 Ageing Report, net migration is expected to converge to zero by year 2035. Where needed Immigration was added to offset decline in working age population (not clear what countries).

[11] Admittedly, this exercise is somewhat limited by the lack of transparency with which important methodological decisions are reported in the relevant documentation (European Commission, 2014, and 2015) and, more relevant to this report, how some of these guidelines were actually adopted in the Portuguese context.
[12] We expect to be able to incorporate migration flows in future versions of this report.

Admittedly, this may result in an underestimation of the total population in DYNAPOR when compared with the projections of the 2015 Ageing Report. Additionally, it could result in changes in the number of people in employment, which could impose a negative bias on indicators of financial sustainability of the Pension System. However, given the fact that Portugal is one of the countries where migration is expected to have the lowest impact on population growth[13], we believe that the decision not to model migration flows will have a relatively minor impact on financial sustainability projections.

In DYNAPOR both fertility and mortality are aligned with the EUROPOP2013 projections (Eurostat, 2017), which are also used in the 2015 Ageing Report. Thus, both mortality and fertility are expected to converge with that of what the AWG identified as the 'forerunners' in the demographic transition – in this case, Northern European countries (European Commission, 2014). In what fertility is concerned, this means that we expect that the historical downward trend that Portugal has experienced in the last decades will be reversed in the period between 2013 and 2020, and that the fertility rate will start to gradually increase to 1.43 by 2040, and 1.52 by 2060 (see Section 3.1).

In the same way, we expect that life expectancy (for both male and female individuals) will continue to grow, particularly for male individuals. Thus, by 2060, the life expectancy at birth is expected to increase by 7.1 years, for male individuals, and by 5.7 for females. In the same way, life expectancy at 65 is expected to grow by 4.7 years for males, and by 4.4 years for females (see Section 3.1).

5.2.4.2. Assumptions about Labour Force Dynamics

In this section we specify the set of assumptions that shape our projections concerning three key labour market aggregates: total employment, unemployment and the number of hours worked. In DYNAPOR both employment and unemployment processes are aligned with employment and unemployment rates projected by the 2015 Ageing Report. As mentioned above, this means that even

[13] In contrast with other nations such as Italy or Norway, where (by 2060) migration flows are expected to be responsible for an increase by more than 20% of the total population, in Portugal the population is only expected to grow by 2.7%. In fact, Portugal is one of the countries where migration its expected to have the lowest impact on total population (European Commission, 2014: 16).

if the selection of individuals into employment or unemployment is based on probabilistic equations, the total number of unemployed persons computed by the model is aligned with an external projection – in this case, the 2015 Ageing Report Projections.[14]

In the 2015 Ageing Report, total employment estimates are produced by multiplying the total population in working-age by the estimated labour force participation rates (which represents he share of individuals in working-age in employment or actively looking for work) then subtracting the total unemployed (as determined by the expected unemployment rate) (European Commission, 2014).

Table 11 Estimated Impact of the Pension Reforms on labour force participation rates for Portugal

Ages	Gender	2020	2040	2060
15-64	Male	1.1	2.9	2.8
	Female	1	3	2.7
	Total	1	2.9	2.8
15-74	Male	0.9	4.1	4.3
	Female	1	4.5	4.5
	Total	0.9	4.3	4.4
20-64	Male	1.2	3.1	3.1
	Female	1.1	3.2	2.9
	Total	1.1	3.2	3
55-64	Male	4.7	11.4	10.8
	Female	3.5	10.2	9.7
	Total	4.1	10.8	10.2
20-74	Male	0.9	4.4	4.6
	Female	1.1	4.8	4.8
	Total	1	4.6	4.7

Source: European Commission, 2014.

Labour force participation rates are estimated by DG ECFIN (European Commission, 2014: 30), using a cohort simulation model (CSM). The participation rates are estimated, according to the following specifications:

- Participation rates by age and gender are estimated using average entry/exit rates observed (using data from the EU Labour Force Survey) in the period between 2004-13;

[14] However, bearing in mind the differences in the assumptions about population growth, this means that even if the total number of employed (or unemployed) individuals does not match to the decimal point, the expected pattern of variation will be in line with that predicted by the 2015 Ageing Report.

- Participation rates for individuals aged 15 to 24 are assumed not to decline, even if educational enrolment is expected to increase;
- Exit rates for individuals aged 55 to 74 are adjusted (relatively to observed values) in order to accommodate the expected effect of the recent pension reforms. In the Portuguese case, exit rates were adjusted bearing in mind the expected impact of changes introduced in 2007 and 2013. As can be seen in *Table 12*, these reforms are expected to increase the participation rates for individuals aged 55 to 64 by 4.1% in 2020, and later by 10.8 (2040) and 10.2 (2060) (see European Commission, 2014: 48-9).

Table 12 Labour Force Projections

	DYNAPOR **Baseline Assumptions**	**Comparability with** **2015 Ageing Report**
Employment	Employment rate is aligned with 2015 Ageing Report projections.	Broadly in line with 2015 Ageing Report, with exception of assumptions about working age population growth, and the labour market participation of younger persons. [a]
Unemployment	2013-2018: Unemployment Rate is expected to converge to structural unemployment rate (NAWRU) 2018-2040: NAWRU/ Unemployment Rate to converge by 2040 2018-2040: NAWRU/ Unemployment Rate fixed to value in 2040	Broadly in line with 2015, Ageing Report, with exception of assumptions about the labour market participation of younger persons, and about the structure of the unemployment rate.[c]
Education	Individuals education attainment is set at birth based on a probabilistic process (see Section 2)	Not in line with 2015 Ageing Report [a]

Hours Worked	Hours Worked are aligned with 2015 Ageing Report projections: • Number of hours worked is kept constant (by reference to 2013), by gender and type of work (part-time vs. full-time); • Share of part-time work is kept constant (by reference to 2013) , by gender and age group (15-24, 25-54 and 55-74)	In line with 2015 Ageing Report

[a] Unlike in the 2015 Ageing Report, in DYNAPOR working age population growth is based on the assumption that there are no migration flows.

The 2015 Ageing Report unemployment projections are based on assumption that the unemployment rate will converge with the structural unemployment rate - or non-accelerating wage rate of unemployment (NAWRU) - i.e. minimum level of unemployment that does not create an inflationary pressure on wages (European Commission, 2014).[15]

As mentioned above, by using the 2015 Ageing Report projections to align the employment and unemployment processes we are able to secure that our labour force projections are broady in line with the established by this report. There are, however, two areas where DYNAPOR labour force projections will diverge from the 2015 Ageing Report projections:

a) The first concerns the labour market participation of individuals aged 15-24. The 2015 Ageing Report assumes that participation rates for individuals aged 15-24 cannot decline, even education enrolment rates increase (European Commission, 2014). DYNAPOR assumes that individuals in education cannot work. Therefore, we expect that, given the assumptions we

[15] This convergence process occurs in two stages:
a) In the first stage, the unemployment rate will converge to the structural unemployment rate for Portugal in 2018;
b) In the period between 2019 and 2040, the unemployment rate is expected to evolve in line with NAWRU, which is expected to converge to
c) From 2040, the unemployment rate is expected to be equal to the structural unemployment rate, which is expected to remain constant until 2060 (European Commission, 2014).

make about the increase in enrolment rates (see Table 8), employment (and unemployment) rates in this age-group will be lower than those projected by the 2015 Ageing Report.

b) The second area concerns the changes in the composition of the unemployment stock. In the 2015 Ageing Report unemployment projections by gender and age are proportionally adjusted to keep the unemployment rate structure in 2013 (European Commission, 2014). In DYNAPOR, the composition of the unemployment stock is the product of a fundamentally probabilistic selection procedure.

In addition to employment, and unemployment, in this report we project how the total number of hours worked is likely to evolve.[16] As shown, DYNAPOR projections are aligned with that of the 2015 Ageing Report. Thus, the number of hours worked, by gender and type of work (part-time vs. full-time), is expected to remain constant by reference to 2013 values. In the same way, the share of part-time work, by gender and age group (15-24, 25-54 and 55-74), is also expected to remain constant.

5.2.4.3. Assumptions about Economic Growth, Productivity, Wages and Inflation

In addition to the assumptions about how key demographic and labour market variables are expected to evolve, our results are based on a set of assumptions on some key macroeconomic aggregates: GDP and productivity, wages and prices. These are crucial assumptions. As previously mentioned, in DYNAPOR, wage growth is indexed to variations in labour productivity. Consequently, the assumptions that are made regarding the expected evolution of labour productivity will certainly have an impact on how social contributions will grow in this simulation and, in turn, on the results regarding the financial sustainability of the Pension System. Additionally, assumptions regarding prices are expected to result in an impact on both the expected evolution of (real) pension expenditure and the evolution of benefits that are indexed to inflation.

For the purpose of this thesis, we assume that both GDP, productivity and prices will evolve in line with the 2015 Ageing Report baseline scenario. The 2015 Ageing Report GDP values are based on

[16] This is a critical issue as this will help to determine changes in earnings.

estimates of potential GDP, i.e. total output adjusted for cyclical variations[17]. As can be seen in Table 13, in the 2015 Ageing Report, EU28 member states potential GDP is expected to evolve to secure convergence in labour productivity. For the period between 2016 and 2023, projected values are based on estimates of potential GDP using a production function estimated under the assumption of convergence in total factor productivity by 2060. The rate and pace of convergence depends on the member-state's starting point.

a. For the group of countries whose GDP per capita equal or above the EU28 average, total factor productivity growth is expected to adjust from the estimated value for 2023 to reach a 1% growth rate by 2045, and to remain at 1% until 2060;
b. For the group of countries whose GDP per capita bellow the EU28 average - or 'followers' (2014), a differentiation is made depending on the distance to the EU-28 average in two intermediate years (2035 and 2046) (European Commission, 2014).

Table 13 Assumptions on speed of convergence of TFP and criteria for selection

GDP per capita (in % of EU28)	Countries	Years (from/to)	Values	Years (from/to)	Values	Years (from/to)	Values
"**Leaders**" (per capita GDP higher than the EU average)							
Above 100%	LU, NL, AT, IE, SE, DE, BE, UK, DK, FI, FR	2023 (t+10) to 2035	From value in 2023 (t+10) to 1%	2036 to 2045	1%	2046 to 2060	1%
"**Followers**" (per capita GDP lower than the EU average)							
Below 100%	IT, ES, SI, CZ, MT, CY, SK, PT, EL, EE, LT, PL, HU, HR, LV, BG, RO	2023 (t+10) to 2035	From value in 2023 (t) to $\frac{1.5\% * \left(1 - \frac{GDP_{i,t}}{GDP_{eu,t}}\right) + 1\% * \left(\frac{GDP_{i,t}}{GDP_{eu,t}} - 0.5\right)}{0.5}$	2036 to 2045	$\frac{1.5\% * \left(1 - \frac{GDP_{i,t}}{GDP_{eu,t}}\right) + 1\% * \left(\frac{GDP_{i,t}}{GDP_{eu,t}} - 0.5\right)}{0.5}$	2046 to 2060	From $\frac{1.5\% * \left(1 - \frac{GDP_{i,t}}{GDP_{eu,t}}\right) + 1\% * \left(\frac{GDP_{i,t}}{GDP_{eu,t}} - 0.5\right)}{0.5}$ to 1%

Source: European Commission (2014: 82).

Table 14 Macroeconomic Assumptions

	DYNAPOR Baseline Assumptions	**Comparability with 2015 Ageing Report**
Potential/Real GDP	GDP expected to evolve as secure a convergence in labour productivity.	In line with 2015 Ageing Report

[17] Bearing in mind that, due to the impact of the financial and the sovereign debt crisis, a number of EU member states have seen significant increases in the their output gat (i.e. the gap between the potential GDP and real GDP), the ECFIN decided to introduce a corrective mechanism by which, in the period between 2013 and 2023, the real GDP growth rate is 0.25% assumed to be higher than the potential GDP growth rate – which would allow for the closure of the output gaps by 2023 (European Commission, 2014).

	Between 2013 and 2023, real GDP growth rate is 0.25% higher than the potential GDP growth rate. Output gap assumed to be closed by 2018.	
Total Factor Productivity	Total Factor Productivity is expected to converge to 1% growth rate by 2060	In line with 2015 Ageing Report
Labour Productivity	Labour productivity expected to converge alongside TFP.	In line with 2015 Ageing Report
Earnings	Real wage growth equals labour productivity growth	In line with 2015 Ageing Report
Inflation	Inflation to converge to 2% by 2018, and remain constant thereafter.	In line with 2015 Ageing Report

In the Portuguese case this has an important consequence that is critical to understand developments in earnings, and crucially in the value of pensions and the redistributive impact of the Portuguese Pension System. Under this convergence scenario, labour productivity is expected to grow at much higher levels than what has been the historical record in recent years. Not only that, this also means that all gains in productivity will translate fully into wage growth, which has not been the case in recent years. As we will show later, this will translate into a significant increase in the average value of pensions in the long term (see Section 7).

Similarly to GDP and labour productivity, this thesis assumes that inflation will evolve in line with th 2015 Ageing Report projections. This means that inflation is expected to converge from country-specific levels at the start of the projection (2014) to 2% by 2018, when the output gap is expected to be closed, and remain at that value thereafter.

5.2.4.4. Other key Assumptions

In addition to set of assumptions described in the previous sections, the results presented here are based on a set of critical assumptions, namely:

i. Results produced here are based on a 'no policy change' assumption, by reference to the rules that were in place by the 1st of January 2017

ii. Assumptions about labour market transitions:

    a. Civil Servants is a closed labour market status, which means there are new entries;

    b. Once individuals move into retirement, they do not return to the labour market;

    c. Individuals leaving education will either move into employment or unemployment;

    d. All individuals aged 70 or over are set as Retired.

iii. Assumptions about the take up of old age pension benefits;

    a. We assume that 30% of those eligible to take-up an early old age pension will do so;

    b. We assume that 30% of those eligible to take-up an CGA early old age pension will do so;

    c. Otherwise, individuals will take up an old age

iv. Assumptions about the take-up of other benefits:

    a. With the exception of the CSI, we assume the full take of benefits. The take-up of CSI was aligned to reproduced the level of take-up registered in 2014;

v. Assumptions about household income:

    a. Capital income, real estate income and housing allowances are not simulated in DYNAPOR.

    b. We use taxable income as the reference to define the household income. This means that household income includes earnings from employment and self-employment and income from pensions from the Public Pension System. Incomes from other benefits (such as unemployment benefits, child benefit and family allowances or minimum income benefits are not considered.

5.3. The Portuguese Notional Defined Contribution System proposed

The basic outline of different NDC pension systems has been previously described (Chapter 3). This section will proceed with a description of how the NDC system was adapted to the Portuguese context in this simulation.

5.3.1. Financing

With regards to the financing of the new NDC system, the contributory scheme that is in place is maintained for two reasons. First, changing the contributory system in the Portuguese scheme would require a total restructure of all the benefits that are financed via Social Security contributions, such as survivor and disability benefits for example, which is not the purpose of this exercise. The focus of this analysis is to analyse the impact of the introduction of an NDC scheme for old age pensions. Second, in order to maintain the two models as comparable as possible (DB and NDC) I have decided to maintain the contributory system unchanged. Consequently, I assume a contributory rate of 34.75% of gross wage to be split between employers (23.75%) and employees (11%).

However, it is important to note that in Portugal, the entirety of Social Security Contributions is not destined for old age pensions. Consequently, out of the total individual Social Security contributions, the amount credited in the notional accounts is equivalent to the TSU (Taxa Social Unica) rate destined for old age pensions (58.16%) of individual contributions. Finally, Tax subsidies are left out in determining the financial sustainability of the NDC old age pension system, since they are considered to be an exogenous policy. Although left out in determining the sustainability of the system, the model is still able to determine the need for tax subsidies to finance the transition to the new system. Consequently, first, the analysis will look at the ability of the NDC system to achieve financial sustainability and second, what would be the necessary amount of tax subsidisation to bring the replacement rate levels up to an acceptable level.

5.3.2. Benefits

This simulation assumes that individuals are able to retire between the ages of 61 and 70 years old. The retirement decision is simulated through an Option-Value model of retirement behaviour. According to this model, individuals will compare the maximum expected value of postponing retirement with the expected value of retiring in the current period. If the expected value of retiring exceeds the maximum expected value of postponing retirement, the individual will effectively retire. One of the assumptions made here is that working over the age of 70 years old will not produce pension credits (similarly to the Swedish pension scheme). As a result, there are no incentives for working after the age of 70 years old and the value of retiring will always surpass the value of remaining in the labour market.

Once the individual decides to retire, an annuity divisor is applied to the amount that the individual has credited in the notional account. The annuity divisor reflects age specific life expectancy and takes gender differences into account. The annuity divisor was determined by using the life tables from DYNAPOR. Once the pension annuity is determined, the amount paid is subtracted from the account. Every year, a new pension amount is calculated that takes into account the changes in life expectancy and the indexation of notional accounts.

5.3.3. Indexation and Balance

Just as savings in a bank earn interest, so do notional accounts. Similarly to the Swedish indexation method, this model assumes that notional accounts are indexed to average per-capita wage growth as measured by the income index. The formula used for the indexation of pensions is the following:

$$I_t = \frac{u_{t-1}}{u_{t-2}}$$

Where I_t refers to the income index at period t and u_t is average wage per-capita. Thus, each period, the notional accounts of all individuals are indexed to wage growth by multiplying the value in the notional account by the income index. If the income index is lower than 1, there is no indexation for

that period, in order for individuals not to lose entitlement on pension credits that were already contributed. Since the notional account uprating strategy focusses solely on wage growth, the system may ignore certain demographic and economic aspects that may force the system into an unsustainable situation. In order to circumvent this possible threat to the system, the automatic balance mechanism (as found in the Swedish pension system) has been added to the simulation.

5.3.4. The Balance Mechanism

The most obvious way to ensure the financial sustainability of any economic system is to ensure that its liabilities do not exceed its assets. This is often the way that funded pension systems are designed. The main issue in applying the same principle to a DB-PAYG system is the lack of an objective methodology to accurately evaluate its primary asset: its contributions. Consequently, the automatic balance mechanism used in the Swedish NDC pension system is essentially a tool used to evaluate the contributions to a PAYG system. Essentially, under certain economic and demographic situations it becomes impossible to earn pension interest on pension credits at a rate equal to the rate of wage growth while maintaining fixed contribution. In order to avoid changes to the contributory system, a balance mechanism is activated that applies a break to the income index used to uprate the notional accounts. The balance ratio is calculated as the ratio between assets and liabilities of the NDC old age pension system. When the balance ratio is below one, the assets of the pension system are not enough to cover the liabilities and the system is out of balance.

The value of the contributions to a pension system depends on the degree to which contributions can finance pension liabilities. The capacity of a given amount of contributions to be able to finance pension liabilities is therefore dependant on the age-related income and mortality patterns of the system. The age-related income and mortality patterns in the Swedish pension system are captured by the turnover-duration (Swedish Pensions Agency, 2016). The turnover duration of the system refers to the expected number of years between the average age of income earners and the average age of pensioners. It is important to note that when estimating the balance ratio, the system is assumed to

have zero population growth. Hence, the balance ratio of the system will measure the system's ability to meet its requirements if the system was closed at that point in time. Therefore, the assets of the system are determined by multiplying the value of contributions by the turnover duration. For example, assume a system with zero population growth and an average age for working population of 45 years. If the average age of pensioners is 75 years, this means that the turnover duration is 30 years. By multiplying the contributions of the current year by 30 we get the contribution assets of the system (provided there is no population growth). Hence:

$$Contribution\ asset = contributions\ \times expected\ turnover\ duration$$

Additionally, the growth in the contribution base is not the only aspect that affects assets. In cases where there is a buffer fund (which is the case in this model) in order to determine the total assets of the system, it is important to consider the buffer fund and the possible returns on it. The buffer fund in this model is calculated yearly and is equal to the amount by which current contributions exceed current pension payments. Thus, the total assets of the pension system are given by:

$$Assets = contribution\ asset + buffer\ fund$$

Up to this point the calculation of the assets has been covered, which leaves the calculation of the liabilities. While the asset calculation is pretty straight forward, the expected liabilities of a pension system takes more into account. The present value of the pension liability is the discounted flow of expected future pension payments represented by the pension liability at the time of measurement (Swedish Pensions Agency, 2016). In a NDC pension system, the pension liability can be thought of consisting of two different parts. First the liability of those who have not yet started to collect their pension and second the liability to those who are already receiving pensions. The pension liability for pensioners that have already began to draw their pensions is the following:

$$PL_{pensioner} = P_a \times 12 \times le_a$$

Where P_a refers to the sum of all monthly pension amounts paid in December of the previous year for individuals with age a, and le_a is the life expectancy for an individual aged a. Finally, the liability of workers is equal to the sum of the NDC accounts of all workers and is given by:

$$PL_{workers} = NPC$$

Where NPC is equal to the sum of all notional pension capital of individuals aged between 16 and 64 years old. Finally, the total liabilities of the system are given by:

$$Liabilities = PL_{pensioner} + PL_{workers}$$

The balance ratio of the pension system is therefore given by:

$$Balance\ Ratio = \frac{Contribution\ Asset + Buffer\ Fund}{Liabilities}$$

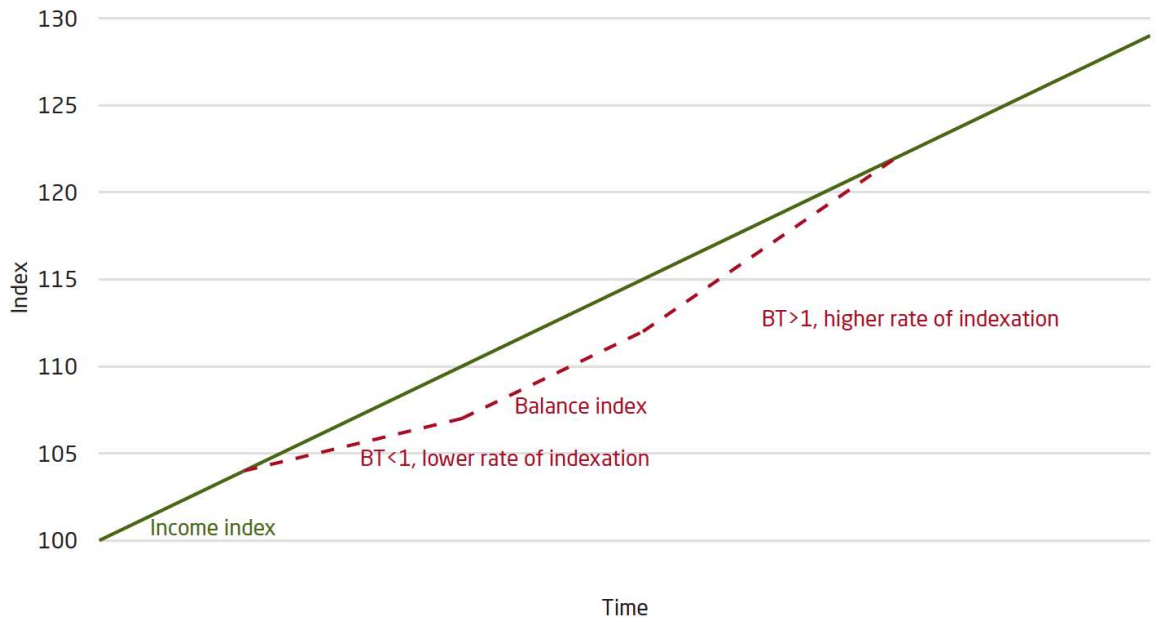
When the balance ratio exceeds 1, the system is in a surplus, since it is able to meet its liabilities with a margin to spare. If the opposite is true, the system is in a deficit and if this situation persists it becomes unsustainable. When the balance ratio is below one, the balance index is activated and notional account balances and pensions are indexed by the change in the balance index rather than the change in the income index. The change in the balance index is determined by the change in the income index and the size of the balance ratio. For example: if the balance ratio falls from 1 to 0.99 while the income index increases from 100 to 104, the damped balance ratio is calculated in the following way:

$$BR_{damped} = \frac{0.99 - 1}{3} + 1 = 0.9967$$

Where BR_{damped} refers to the damped balance ratio to be applied to the income index. By multiplying the income index of 104 by the damped balance ratio (0.9967), the balance index becomes 103.66. This way, notional accounts and pensions are indexed at the lower rate of 3.66 rather than the income index of 4 percent. Once the balance index increases and surpasses the threshold value of 1, the

balance mechanism is deactivated and notional accounts and pensions are indexed again by growth in wage per-capita. An illustration of the balance index is provided in *Figure 22*.

Figure 22 Balance Indexation Example



Source 1: Swedish Pensions Agency (2016)

5.4. The Transition methodology

One of the primary issues regarding the introduction of a Notional Defined Contribution system is the management of the transition. This section focusses on an analysis of the available methodology and theoretical principles for the management of a transition from a traditional DB pension system to an NDC pension system. After a brief search, it is clear that the literature on this topic is scarce. Consequently, much of the theory and practices analysed here are drawn from the work of Palmer (2006).

According to Palmer (2006), there is an initial internal conflict associated with the introduction of an NDC pension system, which results in the differences in pension outcomes for an individual in each of the systems. Suppose that an individual has been contributing to a DB-PAYG system his whole life. This means that the individual has adjusted his or her behaviour according to an expected future benefit. As the author explains, according to standard economic theory, individuals experiencing an

exogenously determined increase in life-time earnings, as is the case in a DB-PAYG system, have a higher preference for leisure and consumption prior to retirement, which in turn has a negative impact on savings. Consequently, by completely changing the system without any regard for these aspects would be unfair towards the individuals that have managed their lives according to the arrangements in place. In his work, Palmer (2006) identifies two principles that need to be taken into account in the conversion of a DB to an NDC scheme: the acquired rights principle and the contribution principle. The acquired rights principle holds that a fair conversion into a new system preserves the acquired rights earned under the previous system. The contribution principle holds that a fair transition to a new system gives rights based on contributions already paid into the old system. Consequently, these two principles also identify the two types of generic models of transition into a new NDC system.

5.4.1. The Acquired Rights Principle

Since it is impossible to accurately determine the exact life spam of an individual, it becomes very difficult to calculate the acquired right an individual is entitled to under a DB scheme until the time of death. Consequently, Palmer (2006) identifies two ways in which we are able to determine the acquired rights of an individual at the time of a transition to an NDC system:

Alternative 1. Wait until the worker retires to compute the acquired right, using the "best possible" cohort projection of life expectancy at the age of retirement.

Alternative 2. Compute the acquired right at the time of conversion. This alternative uses the life expectancy estimate at the time the conversion from the DB to the NDC scheme is to be made.

It is noteworthy that in both of these cases, the pension amounts are heavily dependent on the approach regarding life-expectancy. While in the first alternative, life-expectancy is determined at the age of retirement, in the second alternative it is determined at the current age. It is natural that the difference in the periods should have an effect on life expectancy and, consequently, on the determination of the acquired rights of the individual.

5.4.2. The Contributory Principle

According to the contribution principle, for a transition to a NDC system to be considered fair, it must honour contributions made to the previous DB system. Following this principle, the initial capital in the NDC system is equal to the contributions an individual has paid into the old system. Hence, the initial capital is calculated by the sum of all the contributions made to the system re-evaluated by an assumed rate of return on the notional account. Since this method is the most adequate to the ideology behind the NDC scheme, this work uses the contributory principle as a transition method into the NDC system.

5.4.3. Calculation of the Initial Capital in the NDC System

This section describes the methodology used to calculate the initial capital in the NDC system. Following the contributory principle, the generic formula used to calculate the initial capital is given by:

$$IC_t = \sum_{t=1}^{T} c_t w_t I_t$$

Where c_t refers to the contribution rate at time t, w_t is the wage of the individual at time t and I_t refers to the indexation rate. The indexation rate is assumed to be a constant 1.6 percent as found in the Swedish NDC pension system. Following this equation, the total capital at retirement is calculated as the sum of the initial capital and the following contributions made to the notional account throughout the career up to the age of retirement. Additionally, since I am unable to reconstruct the full earning careers of the individuals, I will be assuming a wage value equal to the reference earnings in the base dataset. Finally, I will be assuming a fixed contribution rate equal to the one used in the DYNAPOR model.

5.4.4. Speed of the transition

In his work, Palmer (2006) identifies three types of transition with regards to speed: new entrants, gradual transition and instant transition. The most straightforward way to introduce a new NDC system is to start with new entrants to labour force. In this type of transition, only individuals that

have entered the labour force for the first time and have never contributed to the previous system will retire under the new NDC scheme. This type of transition naturally preserves the acquired rights of individuals that have already contributed to the old system. However, this type of system takes decades to implement, and since the DYNAPOR model only produces results up to 2060 this is not a viable option.

The second option identified by Palmer (2006) is the gradual transition. The most obvious way to introduce a gradual transition would be to start with a birth cohort (for example all individuals that have entered the labour market after the year 2000). Another option would be to take a gradually weighted mixed system approach (such as the case of Sweden) where individuals draw weighted pensions from each system where the weight becomes larger towards the NDC side in the younger cohorts. The advantages of this type of transition is that it minimizes the individual losses of the "losers" of the transition. However, it also minimizes the gains of the "winners". Nevertheless, the gradual transition undermines the very reason for the introduction of an NDC system: financial sustainability. The lengthy transition period extends the possibility of the old system to generate more deficit that may perpetuate throughout generations (Holzmann & Palmer, 2006).

Finally, an immediate transition has the advantage of breaking away from the old system immediately. It reduces the probability of the old system to generate more deficit, as all individuals that have not yet retired are immediately converted to the new system. The main advantage of this type of transition is that the advantages of the NDC system can be felt from the outset of the transition. According to Palmer (2006), the benefits of this type of transition seem to outweigh the remaining types. For this reason, this thesis will use an immediate transition methodology. Additionally, since the DYNAPOR model is only able to produce results up to 2060, this type of transition provides the best framework to fully analyse the scope of a transition to an NDC pension system in Portugal.

5.5. Analytical Strategy

The analysis of this simulation is done in a comparative step-wise fashion. First, the baseline scenario will consist of the DYNAPOR Defined Benefit system, i.e. the system as it is currently modelled with no reform. Thereafter, the NDC reform is introduced in a series of steps. Each of the steps are described in more detail below.

***Baseline Scenario*:** The baseline scenario consists of the fully modelled DYNAPOR Defined Benefit pension system.

Scenario 1 – Simple NDC: In the first scenario, a simple NDC system is introduced with no redistribution measures or a safeguard guarantee.

Scenario 2 – Simple NDC with a transition safeguard: In the second scenario, a Notional Defined Contribution scheme is introduced with a transition safeguard that guarantees a pension amount of at least 60% of reference earnings for a transitional period that ranges from 2015 to 2030. This transition safeguard is applied to all individuals independent of age during the transitional period. From this point forward, individuals are expected to adjust their behaviour according to the new rules introduced by the new system.

Scenario 3: In the third scenario, a Notional Defined Contribution scheme is introduced with a guaranteed pension amount of at least 60% of reference earnings for a transitional period that ranges from 2015 to 2030. Additionally, a Minimum Guaranteed Pension system is introduced that sets the minimum pension for all individuals aged 65 or over at 24 percent of average earnings registered in the previous year, similar to the Minimum Guaranteed Pension developed in the Swedish NDC pension system. This minimum pension is kept throughout the entire simulation.

***Scenario 4*:** In the Final scenario, a Notional Defined Contribution scheme is introduced with a minimum guaranteed pension for the transition period and the introduction of an Automatic Balance Mechanism similar to the one used in the Swedish NDC pension scheme.

According to the scenarios described, we can clearly see that this analysis focusses on two main aspects of pension reform. The first focusses on the financial sustainability of the pension system (scenarios 1 and 4) while the second focusses on the social and redistributive properties of the system (scenarious 2 and 3). Through this analysis we will be able to determine the transition costs not only for a financially sustainable NDC pension system but also an adequate system.

Chapter 6: Modelling Retirement Behaviour

6.1. Introduction

The study of retirement behaviour came into the spotlight in the 1970's as a consequence of the declining participation rates of older workers during this period in the US. Since then, the models of retirement behaviour have evolved considerably and became increasingly more intrinsic. My goal in this section is to answer the question: what are the available economic models that can be used to analyse retirement behaviour in a microsimulation model? In order to answer this question, I will begin by reviewing the history of modelling retirement behaviour. Next I will look at other microsimulation models and determine what kind of framework is being used to simulate retirement behaviour. Finally, I will develop a retirement behaviour model to be used to simulate retirement behaviour in a Dynamic Microsimulation Model (DYNAPOR).

6.2. History of Modelling Retirement Behaviour

The earliest models employed to analyse retirement behaviour are primarily applications of the single-period (or static) labour supply model where an individual allocates the number of hours spent in work and henceforth the individual is considered to be retired when no hours are allocated to work. An example of the application of this kind of model can be found in the work of Feldstein (1974). In his work, Feldstein (1974) illustrates how individuals respond to Social Security incentives. By using an aggregate consumption function, in his model, individuals are assumed to be retired when consumption is derived primarily through social security wealth. In his work, Boskin (1977), uses a single-period labour supply model to analyse the impact of Social Security coverage on the labour force participation of elderly workers. The results suggest very strong Social Security effects on the decision to retire, however, the author ignores the impact that remaining in the workforce would produce on future benefits. Additionally, Boskin and Hurd (1977), use a similar model to the one used by Boskin (1977) to analyse the impact of Social Security arrangements on the decision to withdraw early from the labour market.

In spite of their contributions to the development of retirement behaviour modelling, these primary models of retirement behaviour quickly came under scrutiny. Although helpful, static models of retirement behaviour largely ignore the dynamic aspect of the decision to retire (Schills, 2005). As known, current employment has an impact on several factors that influence the decision to retire, such as wages and pensions for example. The concept that decision-making involves the balancing between current sacrifices and future benefits, is well embedded at the heart of Economic theory (Hall, 2010). By ignoring these connections, single-period models cast aside the valuable notion of forward-looking behaviour, which represents a key aspect of economic modelling. Even in the work of Feldstein (1974), the importance of forward-looking behaviour was already a clear concept in the retirement behaviour literature. As such, these earlier models of retirement behaviour were, in retrospect, unsophisticated in a number of ways.

Burkhauser (1979), was among the first researchers to incorporate forward-looking behaviour in the modelling of retirement behaviour. The author emphasizes the importance of a multi-period approach to modelling retirement behaviour. Moreover, Burkhauser (1979) considers retirement income as a dynamic variable that rises or falls according to when the benefit is claimed. For example, if and individual decides to retire in the current period, he or she will collect a pension benefit worth X. On the other hand, if the individual decides to postpone retirement for another year, he or she will forego the pension amount this year, however, next year, the pension amount will be X + y, where y represents the retirement credits that the individual contributed in the current year. Therefore, depending on the type of pension system present, the possible future gains of postponing retirement can outweigh the loss of pension income. As a result, Burkhauser (1979) stresses the importance of not looking at the difference between possible income from work and income from retirement at a given period, but instead, to look at the difference between the two streams of income until a given age. Eventually, static models of retirement behaviour were gradually replaced by models that allowed for forward-looking behaviour. This was the turning point, where the modelling of retirement

behaviour moved away from single period models and towards a life-cycle approach where individuals act in a way that maximizes their lifetime utility between labour and retirement.

Following the work of Burkhauser (1979), during the 1980s, new models of retirement behaviour were developed that introduced the intertemporal nature of retirement decisions in the life-cycle approach. For example, in their work, Fields and Mitchell (1984) and Gustman and Steinmeier (1986), provide one of the first and most noteworthy empirical implementations of the life-cycle theory framework, modelling in detail the lifetime income pattern. Fields and Mitchell (1984) use a unique dataset of individuals covered by 10 different pension plans in order to determine the role of economic factors in individual retirement behaviour. In their work, Gustmann and Steinmeier (1986) use a life-cycle model to explain the peaks of retirement at the ages of 62 and 65.

Up to this point, life-cycle retirement behaviour models were designed with an intertemporal utility function. The notion of utility was first established in economic theory during the 1700s and can be found in the works of economists such as Adam Smith for example. As explained in the famous introductory book by Mankiw (2017), *Principles of Economics*, the notion of utility refers to the satisfaction that a person derives from acquiring or consuming a good or service (Mankiw, 2017). In this function, individuals employ an optimization behaviour of the number of hours worked that allows us to derive consumption (C_t) and hours of leisure (L_t). Overall, in each period (t), each individual decides on the optimal number of hours that maximizes his utility. While in static periods individuals made this decision for the current period, in the life-cycle framework they must do this for every available period, hence allowing for the identification of individual preferences regarding lifetime consumption and lifetime leisure. These individual preferences are then represented through an intertemporal utility function (U_t). The utility function of an individual under a life-cycle model can be written as follows:

$$U_t = \sum_{t=0}^{T} \frac{1}{1+\delta_t} U(C_t, L_t)$$

Where δ represents the subjective discount rate, C_t represents consumption and L_t is leisure. Above the sigma, the T represents the remaining lifespan of the individual. In this function, individuals will maximize their utility by choosing the optimal amount of consumption (C_t) and leisure (L_t) for each of the periods during their remaining lifespan. Although this kind of model is a big step forward from the previous single period models, there are still some issues that need to be taken into consideration. Up to this point, most models assumed a world of certainty where individuals make their decisions based on their current situations and the information available to them, i.e. information regarding current and future labour market status, income and retirement income. They assume their current status as the point of reference against which they wager future options. However, in reality, this may not be the case. People are exposed to a great deal of external factors that may influence their decisions. Variations in health, layoffs, deterioration of labour market conditions or changes in pension rules are all factors that may influence the expected future utility of an individual. Additionally, none of the models described so far considered different pathways to retirement. For example, in order to retire, an individual does not necessarily need to come from employment. In Portugal, for example, individuals can retire from being unemployed or even disabled as long as they meet the necessary requirements to collect a pension (in most cases at least 15 years of contributions).

The 1990s was a decade of improvement in retirement behaviour modelling. Led by concerns regarding the lack of uncertainty in the life-cycle model, Rust (1989) introduced the first application of the Dynamic Programming Model (DPM) in the retirement behaviour literature. In order to explain the Dynamic Programming Model, it is necessary to consider the economic theory and rationale that has led to the development of this model. In order to do so first we need to begin by explaining the consumption-leisure framework that served as the basis for earlier models. In this framework, individuals are seen as rational economic agents that are interested in consumption. Under this assumption, individuals chose a number of hours worked (H) to derive wage (w) in order to achieve an optimal balance between consumption (C) and leisure (L) where the weight of each of these

parameters is directly linked their personal individual preferences. Since individuals value both C and L, it is assumed that the utility function used to describe this process is increasing in both arguments:

$$\frac{\partial U(C,L)}{\partial L} > 0\,, \frac{\partial U(C,L)}{\partial C} > 0$$

The economic relationship between leisure and consumption can be expressed via a budget constraint. In this sense, consumption is given by the sum of labour income that is acquired by means of working H hours for wage *w*, non-wage income originating from pensions or other types of benefits (Y_B) and personal wealth (Y_O). Hence, the budget constraint of the consumption-leisure framework can by expressed by:

$$C = wH + Y_B + Y_O$$

In this equation, H is calculated through T – L, where T represents total hours and L represents leisure. As such, the equation for the budget constraint of the consumption-leisure framework can be rewritten as:

$$C = w(T - L) + Y_B + Y_O$$

Drawing on the assumption that individuals are rational economic agents and attempt to maximize consumption, the choice of the number of hours worked is determined by the optimization of utility. The optimisation of utility, given that the individual acts as a rational economic agent that optimizes both consumption and leisure is written as follows:

$$max\ U(C,L)$$

Now, assuming the consumption is derived from the consumption function described above, the individual is considered to be retired when consumption is derived solely from pensions (Y_B). Every period, the individual allocates his hours of work and leisure according to his preferences and either draws consumption from earnings from work, pensions or both. Up to this point, the model is still considered to be a static model in which the budget constraint and the utility function include present

consumption, income and leisure. However, as previously seen, labour market decisions are not static processes. Instead, if working an extra year means that the individual can withstand to earn considerable benefits in terms of pension, than postponing retirement may be considered as an attractive option. Since future opportunities and preferences may influence the decision to retire from the labour market the analysis of retirement behaviour should be done in a life-cycle context. Hence we arrive at the life-cycle model of retirement behaviour which implements forward looking behaviour and, as previously seen, is given by:

$$U_t = \sum_{t=0}^{T} \frac{1}{1+\delta_t} U(C_t, L_t)$$

This is the equation that has led to the dynamic programming model. Up to this point individuals make their decisions based on consumption and leisure in order to maximize their utility over their lifetime. As shown, consumption can be derived from earnings from work, pension or other benefits and personal wealth. The decision to retire is made by deriving evaluating all possible periods and selecting the choice that will maximize utility over remainder of life for the individual. Here is where the Dynamic Programming model of retirement behaviour is born. First, an error variable is introduced that reflects uncertainty. In this sense, uncertainty may refer to a variety of factors that may influence behaviour, such as illness, loss of income due to labour market conditions and any other factor that may influence future utility. Hence we get the following equation:

$$U_t = max \sum_{t=0}^{T} \frac{1}{1+\delta_t} \mu_t U(C_t, L_t)$$

Where μ_t refers to the error discussed above and δ_t is the preference for timing of retirement of the individual. The other great improvement to the general life-cycle model of retirement behaviour brought about by the dynamic programming framework is the introduction of different pathways to retirement. Considering that an individual may have different pathways to retirement, the dynamic

programming framework considers the difference between future streams of leisure and consumption at present discounted values (PDV). The equation can therefore be re-written as follows:

$$PDV^k(t) = \sum_{s=t_0}^{t-1} \frac{1}{1+\delta_t}\ \mu_t\ Y_s^W + \sum_{s=t}^{T} \frac{1}{1+\delta_t} \mu_t\ Y_s^k(t)$$

Where Y_s^W represents labour income for period *s* and *k* represents the different labour market states possible for the individual to integrate. In this sense, we are able to consider more than one pathways to retirement. However, as we have previously seen, the decision to retire from the labour market is not solely dependent on income alone. Instead, leisure also plays a key role in this decision. Hence, the total value of retirement at a given age is given by a cumulative utility function (V(t)), which represents the sum of all one period utility values over the life-cycle discounted by time preferences and corrected for the impact of uncertainty on retirement behaviour. The retirement problem can, therefore, be represented by the maximization of intertemporal utility assuming that the individual currently possesses the necessary knowledge regarding future earnings and pensionable income in the following way:

$$V(t) = max_{d_t^k}\left[\sum_{s=t_0}^{T} \frac{1}{1+\delta_t}\mu_t \sum_{k\in D_t} U^k\left(Y_t^k, L_t^k\right) d_k^t\right]$$

Where D_t represents the current choice set that is the result of past choices and d_k^t takes the value of 1 if individual is currently in labour market state k.

As previously stated, the first implementation of a DPM of retirement behaviour can be found in the work of Rust (1989). In Rust's stochastic DPM, individuals optimize over age of retirement and future consumption simultaneously taking labour market state into account (full-time, part-time and retired). This means that each period that passes individuals make expectations regarding future uncertain variables. With each new period, these expectations are updated in order to reflect newly available information. In this new model, individuals behave in the way which they can derive the most value between the current period and the remainder of their lifespan. Each period, the individual decides

whether to retire and derive utility from a pension or to continue working and derive utility from wage and keep the option to re-evaluate the option to retire in the following period. Although limited in scope with regards to labour market options, the work of Rust (1989) provided the stepping stone for the development of a new model of retirement behaviour.

Other applications of the Dynamic Programming framework can be found in the works of Daula and Moffitt (1995) and Berkovec and Stern (1991). In the first, the authors use a Dynamic Programming Model to study retirement behaviour in the military where each period, the individual has to decide whether to remain or leave the service. In the latter, Berkovec and Stern (1991) develop a DPM that allows for four different transition paths – remaining in the current job, switching to a new full-time job, partially retiring and fully retiring. Both models specify error terms and a value function that depends on age, years of contributions or career length, and other exogenous variables. Building on the work by Rust, Rust and Phelan (1997), build a powerful dynamic programing model to analyse the impact of Social Security on the retirement decision of older Americans. In their work, the model built allows for uncertainty and multiple pathways for retirement. Additionally, by applying a maximum likelihood method of estimation, the authors were able to reproduce the pronounced retirement peaks at the ages of 62 and 65 that are found in the US, which was only ever accomplished in the Gustmann-Steinmeir model previously mentioned. Rust and Phelan (1997) showed that the Dynamic Programming model is superior to previous models in its ability deal with the heterogeneity in terms of individual labour supply paths to retirement. Additionally, the authors demonstrate that one of the main advantages of the Dynamic Programming model is its ability to measure the impact of uncertainty and to provide a framework that allows for intertemporal evaluation of opportunities.

In spite of all its traits, Dynamic Programming models also have a downside, the so called “curse of dimensionality”. The term, notoriously coined by Richard Bellman (1957), the father of Dynamic Programming, is first used in the preface of his 1957 book “Dynamic Programming” and refers to the complexity of determining the maximization of a function, especially when the number of variables

that compose said function is large. Hence, one of the greatest drawbacks of Dynamic Programming Models is the enormous burden in regards to the time and space that is necessary to solve the model (D. Li, Wang, Wang, & Yao, 2008). The computational requirements necessary to solve it become even greater when the assumptions that guide the model parameters are relaxed and the model becomes more robust. As a result, the evolution of more complex Dynamic Programming Models will always be closely linked with technological advancements and the increased computational power that results from it.

In response to concerns regarding the complexity and the computational power necessary to develop a Dynamic Programming model, during the 1990s a new model was developed that resembles the Dynamic Programming model to a certain degree and has more relaxed requirements in terms of complexity and computational power – the Option-Value model (OV). The Option-Value framework was originally used in the work of Stock and Wise (1990) to study the effects of pension plans on the retirement behaviour of older Americans. For this purpose, the authors proposed a new structural model of retirement behaviour that was eventually estimated on a pension plan firm dataset. The approach used by Stock and Wise is, arguably, simpler that the DPM framework. The decision to retire in an Option-Value model is done similarly to that in the life-cycle approach. Every period, the individual compares the expected present value of retiring immediately against the expected present value of retiring at each future age. However, as the individual crosses to another period and receives new information, he or she will re-evaluate his decision, as in the Dynamic Programming Model. The option value for the decision to retire refers to the maximum value of the differences between the value of retiring in the current period and the value of retiring in all future periods. If the option value is positive, the individual will remaining in work and postpone retirement. On the other hand, if the option value is negative the individual will retire. The primary difference between the OV and the DP framework is best expressed by Lumsdaine (1999), which describes the decision to retire in the OV as an evaluation of the maximum of expected present values, while the DP is an evaluation of a series of

expected present values. Hence, the decision to retire in an option-value model, as defined in Stock and Wise (1990), is given by the value function:

$$V_s(R) = \sum_{t=S}^{R-1} u\,(Y\,Lab_t^{NET})\,\delta^{t-S} + \alpha \sum_{t=R}^{T} u\Big(Y\,Ret_t^{NET}(R)\Big)\,v_t\,\delta^{t-S}$$

Where R represents retirement date, δ^{t-S} is the discount factor and u is the probability of being alive at some future date conditional on being alive today. Very few authors were able to replicate the econometric work done by Stock and Wise (1990). Instead, most authors have adopted the Option-Value framework in its reduced form context. The most common application is to assume preferences and individual valuation of leisure at a constant rate and to estimate the value function as a linear regression to enter in a probit model (Börsch-Supan, 2000; Borsch-Supan & Berkel, 2003). The first comparison between the Option-Value and other models can be found in the work of Lumsdaine, Stock, and Wise (1992), where the authors compare the predictive validity of the Option-Value framework with that of two different Dynamic Programming Models, namely an adaptation of the models presented in Berkovec and Stern (1991) and in Daula and Moffitt (1995). The authors conclude that, in spite of their differences in computation requirements and complexity, the OV and the DP models perform equally well in predicting the retirement behaviour of individuals. Authors, such as Burkhauser, Butler and Gumus (2003) go so far as to show that, in certain conditions, the OV may even outperform the DP.

In spite of its attributes, the OV presents some methodological drawbacks that should be taken into consideration. In their work, Coile and Gruber (2000) argue that while theoretically attractive, the implementation of an OV model runs into an important difficulty in the retirement regression context, namely that the vast majority of variation in the option value is derived from variation in wages. This means that a researcher that is interested in measuring the effects of social security policy on early retirement for example, may end up, for the large part, measuring income dispersion instead. As an

alternative, the authors suggest the use of the "peak value", which is defined as the difference between total discounted pension wealth at its maximum expected value and its value if retirement occurs immediately (Coile & Gruber, 2000).

The modelling of retirement behaviour has been evolving at a steady pace over the years. From early single period consumption/leisure models, where retirement was treated as a standard labour supply choice and the individual assigned the number of hours he wished to work in order to be able to meet consumption preferences towards more forward looking models such as Dynamic Programming and Option-Value models that incorporate uncertainty and multiple pathways to retirement. In terms of comparison, although the option-value model is a much simpler implementation when compared to the Dynamic Programming model, studies have shown that in terms of predictive ability the results are very similar. Some studies have even shown that given a specific set of circumstances, the Option-Value model may even outperform the Dynamic Programming approach. A comparison between Option-Value models and more recent models will depend on the context of the analysis. Although in some cases the use of more complex models may result in a better approximation of actual behaviour, there are situations where the retirement decision making is simpler and therefore more suitable to be modelled under an Option-Value model.

6.3. Modelling Retirement Behaviour in a Dynamic Microsimulation Model

Much attention has been devoted to econometric models as a new tool for dynamic microsimulation. In particular, econometric approaches to retirement behaviour provide great tools for calibrating dynamic microsimulation models aimed at converting the decision to retire endogenous, which in turn can greatly improve the ability of a model to analyse policy reforms (Spataro, 2005).

For example, if we look at the Swedish SESIM model documentation (Flood et al., 2012), retirement behaviour is modelled under an option-value framework. In SESIM, the retirement decision focusses mainly on early retirement, which is described as retirement before the age of 65 years old. Additionally, all individuals are forcefully retired at the age of 65 if they have not done so by then. In

the Swedish model of retirement behaviour, the individual is faced with two choices: to retire or to remain in work. The economic incentives that will define the decision are represented by two variables: the net present value (NPV) of future pension benefits and the accrual value of NPV. The option-value model used in SESIM can be written as follows:

$$OV := NPV_t^W - NPV_t^R$$

Where, NPV_t^W refers to the net present value of working at time t and NPV_t^R refers to the net present value of retiring at time t. Following the model used, the net present value of working until age 65 is given by:

$$NPV_t^W = \sum_{s=t}^{64} \delta^{s-t}\, Y_s + \sum_{s=65}^{T} \delta^{s-65} B(s, 65)$$

Where *B(t,r)* denotes the pension benefits received after period t and Y_s refers to labour income earned up to the age of 65. The net present value of retiring in the current period is given by:

$$NPV_t^R = \sum_{s=t}^{T} \delta^{s-t} B(s, t)$$

This measure is often referred to as Social Security Wealth (SSW henceforth). Additionally, the NPV calculations in the SESIM model include a time preference factor of 3 percent and survival probabilities collected from exogenous survival tables (Flood et al., 2012). It is important to note that this method of simulating retirement behaviour is outdated with regards to the rules of retirement in Sweden. As stated in the SESIM documentation, there is a need to develop a new model of retirement behaviour that considers the new retirement rules, namely the retirement window from 60 to 67 years old.

In spite of the attributes of the option-value framework in a Dynamic Microsimulation Model, there are other approaches that have been taken. The Australian microsimulation model APPSIM uses parameters from a series of equations to estimate the probability of retirement at a given age. The Italian model CAPP_DYN uses a life-cycle approach where each individual eligible to retire will weigh

net social security wealth of retiring against net social security wealth of postponing retirement. Additionally, in the Italian model, an extra parameter is introduced that controls for pension adequacy where individuals are only allowed to retire if the replacement rate exceeds a certain threshold set at 60%. In DYNASIM3, a dynamic microsimulation model simulated by the Urban Institute in the US, the decision to retire is simulated by a retirement submodule that comprises a two equation behavioural model that is implemented for all workers aged 58 and older (J. Anderson, 1997). The first stage of the behavioural model simulates if the individual leaves the current as a function of age, sex, disability, marital status, full or reduced pension status, social security eligibility, wage, earnings, social security wealth and its change if retirement is delayed one year, and pension wealth and its change if retirement is delayed one year. In case the worker leaves the current job, the second stage of the behavioural model in DYNASIM3 estimates the probability of the worker to get a new job as a function of a similar set of variables (J. Anderson, 1997). In DYNACAN, the Canadian microsimulation model, there is no behavioural retirement function that responds to economic incentives. Instead, retirement behaviour is specified as exogenous assumptions based on tabulations of administrative data, with worker retirement decision as a function of age, gender and disability status.

Having reviewed some of the Dynamic Microsimulation Models, it is clear to see that there is a wide range of options that may be used to simulate retirement behaviour in this context. However, it is important to note that different models are developed for different analysis and the focus of the models may not always be on social security policy analysis. As a result, the level of emphasis given to retirement behaviour may differ from model to model. In this thesis, the objective is to analyse the impact of a transition from a DB-PAYG to a NDC system on the fiscal and social sustainability in Portugal. For this purpose, the modelling of retirement behaviour is a key aspect of this exercise. The next section will describe and justify the methodological choices for modelling retirement behaviour in this thesis.

6.4. Justifying the need for an Option-Value framework

Dynamic microsimulation models suitable to analyse the implications of public policies have been growing in numbers over the last few years. The development of this type of models has profited from the increasing availability of data, improvements in analytical procedures and technological advancements, which have made the construction of more robust models possible. Nonetheless, the development of Dynamic Microsimulation Models remains a challenging affair that has several implications regarding the methodologies used for such an endeavour.

One of these implications has to do with the type of methodology used to simulate individual behaviour. Li and O 'donoghue (2013) identify three different approaches that can be used to simulate individual behaviour in Dynamic Microsimulation: structural behaviour models, reduced form models and simple transition matrix. Structural models are grounded on economic theory, which means they are based on the assumption that institutional and market changes are expected to produce an effect on individual behaviour. On the other hand, reduced form models are used to estimate the probability that an individual transitions from one state to another according to a set of characteristics. Reduced form models are often aim to reproduce observed distributional characteristics without taking into account policy considerations. Hence, reduced form models do not account for external market and institutional characteristics and often assume a stable policy environment. The final method identified in Li and O'Donoghue (2013), transition matrix, is often simulated under a time-homogenous Markov chain with limited number of states.

As seen, reduced form models and transition matrices often assume a stable policy environment. Hence, they are mostly used to simulate mortality, fertility or labour market behaviour under a status quo assumption. Since these types of models are not responsive to policy parameters, they are not suited to analyse policy reforms (J. Li & O 'donoghue, 2013). On the other hand, structural models are designed specifically to analyse individual behaviour in a context that allows for multiple decisions. As seen above, the most common way of formalising the relationship between exogenous incentives and

decision making is through the mathematical framework of utility optimization. Individuals act in a way that optimizes their levels of leisure and consumption according to their individual preferences.

In spite of its wide use, and, to a certain degree, as a result from it, the last couple of decades have seen an intensification of the methodological scrutiny of the utility framework. The most common critique found in the literature argues against the validity of the premise of the maximization hypothesis (Leibenstein, 1979; Simon, 1979). Instead, critics argue that individuals do not necessarily act in a way that maximize behaviour in all circumstances. For this reason, the focus of utility theory on numerical optimization of consumption is perceived as unrealistic (Simon, 1979). A common application of this criticism is in the economic consideration that individuals are short-sighted and employ myopic behaviour, exhibiting time preference when they allocate more consumption to the present than to the future (Davis, 2003). Hence, individuals do not behave in a way that maximizes their utility over the life-cycle. Instead, they give preference to current consumption. In spite of this criticism, Friedman (1953) argues that the ultimate goal of a positive science is the development of a theory that produces meaningful predictions about unobserved phenomenon. In this sense, the usefulness of utility theory lies in its inherent ability to reflect reality and not in its ability to accurately describe the decision process (Sefton & van de Ven, 2009). Seen from this perspective, utility theory can be perceived as a mathematical tool for understanding individual behaviour.

Among life-cycle models of utility, the Dynamic Programming framework is still the most widely used model to analyse individual behaviour. One of the advantages of this type of model is that it considers uncertainty. In their work, Browning and Lusardi (1996) review most of the literature regarding uncertainty. The authors conclude that there are significant theoretical results supporting the inclusion of uncertainty in the life-cycle framework. However, as previously mentioned, the development of a Dynamic Programming model of individual behaviour is a costly, time consuming and technologically challenging endeavour. Taking into considerations the limitations associated with implementing a Dynamic Programming model, I have opted to simulate the retirement decision by

using an Option-Value approach. As previously stated, with regards to predictive validity, the Option-Value approach to retirement behaviour can produce results that are very similar to the Dynamic Programming. However, one of the advantages of opting for the Option-Value model is that it is much less costly to implement and it does not require a great deal of computational power. It is important to note that a Dynamic Microsimulation model is, by itself, already a computationally intensive model.

However, the methodological choice of the Option-Value model is not restricted to aspects of computational power and time consuming implementation associated with the Dynamic Programming. In order to justify the use of the Option-Value framework it is necessary to refer back to the primary goal of this thesis: to analyse the fiscal and social impact of a shift from the traditional DB-PAYG to a NDC system in Portugal. Since we are analysing the impact of policy reform, it immediately excludes reduced form models. Additionally, the very nature of an NDC pension system is different from the DB-PAYG and therefore it is important to be able to capture the possible behavioural changes that may occur in the conversion of one system to the other. For example, the longitudinal nature of the time spectrum in the individual decision to retire in an NDC scheme immediately poses problems in using a single-period consumption/leisure model. The use of a single-period model of retirement behaviour would largely ignore one of the aspects that defines a NDC system, i.e. the closer link between benefits and contributions. Additionally, in a DB-PAYG that considers the average between the last 40 years, provided that the individual has a full career, an extra year of work would have a small impact on the pension level. On the other hand, in a NDC framework, contributions are credited in a notional account that is converted into an annuity at the time of retirement. The direct link between contributions and benefits means that individuals are automatically rewarded with a higher pension for every extra monetary unit of contributions paid, which serves as the basis for the NDC's claim of fairness. Given that every marginal unit of contributions results in an equivalent pension right, the NDC system attempts to mitigate the disincentive to contribute that is associated with traditional DB-PAYG schemes (Chłoń-Domińczak,

Franco, & Palmer, 2012). Consequently, it is reasonable to assume that individuals are more conscious of the impact of their decision to retire and assess their options more carefully.

As seen, the literature on retirement suggests a range of different approaches to model retirement behaviour. Above, I have distinguished between single-period consumption/leisure models, life-cycle budget constraint models, dynamic programming models and option-value models. While each of the models has its own merits, not all are suitable to simulate retirement behaviour in this exercise. For instance, single-period consumption/leisure models are an over-simplification of the retirement problem and may produce misleading results. Additionally, Life-Cycle Dynamic Programming models are computationally intensive and therefore difficult to include in a Dynamic Microsimulation Model (Klevmarken, 2010). On the other hand, option-value models present an opportunity for modelling retirement behaviour in a Dynamic Microsimulation Model, since they possess a predictive validity that is very close to the Dynamic Programming model and are not nearly as computationally intensive. Finally, the structural model adopted for the purpose of simulating retirement behaviour reflects the general view that as long as individuals are influenced by institutional incentives, a structural model is the best option to simulate the effect of pension policies on individual behaviour towards retirement.

6.5. An overview of the retirement behaviour model developed

Under the new NDC system developed for the purpose of this thesis, individuals will have the option to retire between the ages of 60 and 67 years old. Following the Option-Value framework, each period the individual will have the option of remaining in work or retiring from the labour market. The decision to retire is done by an evaluation of the present value of retiring on the current period and the maximum value of retiring between the current period and the period at which the individual reaches the age of 67 years old. Let $E_t V_t(r^*)$ denote the expected value of working and retiring at r, $E_t V_t(t)$ denote the expected value of retiring at the current period and r^* denote the value of r that maximizes $E_t V_t(r^*)$, the Option-Value model used can be written as follows:

$$G_t(r^*) = E_t V_t(r^*) - E_t V_t(t)$$

Where the individual will postpone retirement only if $G_t(r^*)$ is positive. The Option-Value adopted here follows the general model used in Stock and Wise (1990). Thus for the individual, the expected value of postponing retirement is given by:

$$V_t(r^*) = \sum_{t=s}^{R-1} \delta^{t-s}\, U_w(Y_S) + \sum_{t=R}^{T} \delta^{t-T} U_R[B_S\,(r)]$$

Where U_w refers to the instantaneous utility of work that takes as its argument the value of earnings from work and U_R is the instantaneous utility of retirement and takes as its argument the value of retirement benefits. In this case δ refers to a discount factor that will be explained in more detail ahead. Finally, T is the life expectancy of the individual in the current period. The life-expectancy (T) is provided by the lifetables that are generated from DYNAPOR. The discount factor applied refers to social security contributions in order to avoid double counting of income from work.

In this model, uncertainty about future income is modelled under a risk aversion parameter (γ). An additional parameter (k) is introduced to denote individual preference for income while retired. This parameter is the relationship between a unit of income obtained as retired and a unit of income obtained as working. As a result if parameter k > 1, then the individual has a greater preference for income as retired versus income obtained by working. This parameter is used to account for individual preference for leisure. Hence, the utility functions for working and retirement can be written as follows:

$$U_w(Y_S) = Y_S^{\gamma}$$

$$U_R\big(B_S(R)\big) = [kB_S(R)]^{\gamma}$$

Usually, parameters k, γ and δ are computed through maximum likelihood estimation. A simple alternative to a full maximum likelihood estimation of an Option Value model is to specify retirement in terms of the gain from continuing to work, computed on the basis of some assumed values for k, γ

and δ Bingley et al. (2004). Consequently, I assume a discount factor δ of 0.97, the risk aversion parameter γ of 0.75 and the utility income comparison k of 1.5 previously estimated in Stock and Wise (1990). Finally a new discount factor (u) is applied to Y_S^{γ}. The discount factor applied refers to social security contributions in order to avoid double counting of income from work. For example, in the NDC, the individual contributions are credited into a notional account that are later converted into an annuity. If I include the contribution amounts in the income from work I will be adding these amounts twice: once in the income from work and another time in the pensionable income after they are converted into an annuity. As a result, discount factor u is applied in order to circumvent this issue, which refers to the discount rate for social security.

Following the Option-Value framework, the expected value of retirement in the current period is given by:

$$V_t(t) = \sum_{t=R}^{T} \delta^{t-T} U_R[B_S(r)]$$

Since I am using the DYNAPOR model, this will simplify the construction of the model since we are able to determine expected earnings from work and expected pension benefits using the social security and labour market module. The determination of yearly income in DYNAPOR is done by two distinct process: the hours process and hourly earnings process. The hours process begins with a logit equation that attributes a score to individuals according to a set of characteristics. This process differentiates between males and females and employees and self-employed workers. Afterwards the procedure of alignment by sorting selects the individuals that will be characterized as part-time for the current period. In this process, the individuals are sorted according to the scores provided in the previous step by the logit equations. The number of individuals to be selected is determined by then determined by the alignment table. The individuals with the highest part-time scores are selected first. Finally, the number of hours worked is attributed to each individual by the linear regression equation previously estimated. This equation differentiates between males and females and also takes into

account employees and self-employed workers. The equations used to estimate weekly hours for full-time workers are the following:

- $Whours^{Employee} = \alpha + \beta_1 * age + \beta_2 * age^2 + \beta_3 * nchild0\_10$
- $Whours^{Self-Employed} = \alpha + \beta_1 * age + \beta_2 * age^2 + \beta_3 * female$

Where $nchild0\_10$ refers to the number of children aged 0 to 10 years old residing in the household and $female$ is a dummy that takes the value 1 if the individual is female. Although the predictors are the same for males and females, the coefficients differ according to gender resulting in a total of 4 equations. Finally, the equation used to estimate weekly hours for part-time workers is:

- $Whours^{part-time} = \alpha + \beta_1 * age + \beta_2 * age^2 + \beta_3 * female$

In similar fashion, the same predictors are used to estimate weekly hours for employees and self-employed, however the coefficients differ. Unlike the previous equations there is no different equation used to estimate part-time worker weekly hours for males and females. Instead, a dummy was used that takes the value 1 if the individual is female and the value 0 if the individual is male.

After estimating the weekly hours worked, the model proceeds to estimate the hourly earnings for each individual that is currently in the labour market. The hourly earnings estimation is done in a two-step procedure. First the earnings per hour of wage earners is estimated through the following equations:

- $hearns_{males} = \alpha + \beta_1 * age + \beta_2 * age^2 + \beta_3 * tertiary\ education + \beta_3 * public\ employee$
- $hearns_{females} = \alpha + \beta_1 * age + \beta_2 * age^2 + \beta_3 * tertiary\ education$

Where $tertiary\ education$ and $public\ employee$ represent dummies that take the value of one if the individual has tertiary education or is a public employee (which includes both public employees and civil servants). As shown, there are two separate equations: one for males and another for females. The second step estimates earnings per hour for self-employed individuals. The equation used is as follows:

- $selfhearns = \alpha + \beta_1 * age + \beta_2 * age^2 + \beta_3 * female + \beta_3 * tertiary\ education$

Although there is only a single equation for both males and females, there is a predictor takes the value of 1 if the individual is female and the value of 0 if the individual is a male. Finally, after estimating weekly hours and hourly earnings, yearly earnings are computed as follows:

- $Y_s^W = Whours \times Hourly\ Earnings \times 52$

With regards to Social Security Wealth, since DYNAPOR has all the information necessary to calculate the exact pension that the individual would be entitled to, I will simply run it through the social security module and determine individual pension entitlement according to the rules in place. This way it is not necessary to develop any set of equations in order to estimate the value of social security wealth for each individual.

Chapter 7: Financial and Social Sustainability of the Portuguese Pension System under a transition to an NDC scheme.

This section aims at providing a quantitative analysis of the results of the simulations performed. The analysis is done across seven groups of indicators. The following is a brief description of the groups and the indicators that comprise them.

Group 1: Demographic (Total Population, Total Population by Age group, Demographic Dependency Ratio, Old-Age Dependency Ratio, Average Age).

Group 2: Labour Market Dynamics (Working Age Individuals, Labour Force, Participation Rate, Employment Rate, Unemployment Rate, Average Labour Force Age).

Group 3: Demand for pensions (old age pensioners (total), old age pensioners by pension type)

Group 4: Expenditure (Total Expenditure, Expenditure by pension type)

Group 5: Financial Balance (Contributions total, Contributions for old age pension, Financial Balance)

Group 6: Social Sustainability (Average old age pension, average old age pension by type of pension)

Group 7: Adequacy (Benefit Ratio, Benefit Ratio by type of pension, Gross Replacement Ratio, Gini coefficient).

It is important to note that although the first group of indicators should be the same for all scenarios, the same cannot be said of the remaining groups. Consequently, from group 2 onwards each Figure will contain the results of each scenario providing the best framework for the analysis of the results in a comparative manner. The scenarios simulated in this thesis are the following:

***Baseline Scenario*:** In the base line scenario the current Defined Benefit Pay-As-You-GO pension system is simulated according to rules in place on the 1st of January of 2017.

***Scenario 1*:** In the first scenario, a Notional Defined Contribution scheme is introduced. In this scenario there is no redistribution measures or an Automatic Balance Mechanism in order to boost the Social and Financial Sustainability of the system.

***Scenario 2*:** In the second scenario, a Notional Defined Contribution scheme is introduced with a transition safeguard that guarantees a pension amount of at least 60% of reference earnings for a transitional period that ranges from 2015 to 2030. This transition safeguard is applied to all individuals independent of age during the transitional period. From this point forward, individuals are expected to adjust their behaviour according to the new rules introduced by the new system.

Scenario 3: In the third scenario, a Notional Defined Contribution scheme is introduced with a guaranteed pension amount of at least 60% of reference earnings for a transitional period that ranges from 2015 to 2030. Additionally, a Minimum Guaranteed Pension system is introduced that sets the minimum pension for all individuals aged 65 or over at 24 percent of average earnings registered in the previous year, similar to the Minimum Guaranteed Pension developed in the Swedish NDC pension system. This minimum pension is kept throughout the entire simulation.

***Scenario 4*:** In the Final scenario, a Notional Defined Contribution scheme is introduced with a minimum guaranteed pension for the transition period and the introduction of an Automatic Balance Mechanism similar to the one used in the Swedish NDC pension scheme.

7.1. Population Change and Age Structure

As a start to this analysis, I will look at how the demographic dynamics evolve in the period under consideration (2015-2060). It is important to note that these results are the same for all Scenarios since they are all simulated using the same alignment tables. Taking into account the natural change, i.e. the relationship between births and deaths in the simulation period, there is an expected decrease in the total population. As shown in Figure 23, on the 31st of December of 2015, the resident population in Portugal is expected to account for 10.4 million individuals. Throughout the simulation, there is an expected drop of 24 percent in the total number of individuals, reaching 7 886 125 by 2060.

In contrast, the Ageing Report 2015 projections anticipate a change in the EU28 population of only 2 percent between 2020 and 2060. A possible reason for this difference is that the Ageing Report assumes a positive net migration of 2 percent of the resident population per year, which in turn counters the effect of the relationship between births and deaths.

Figure 23 Total Population projection, 2015-2060

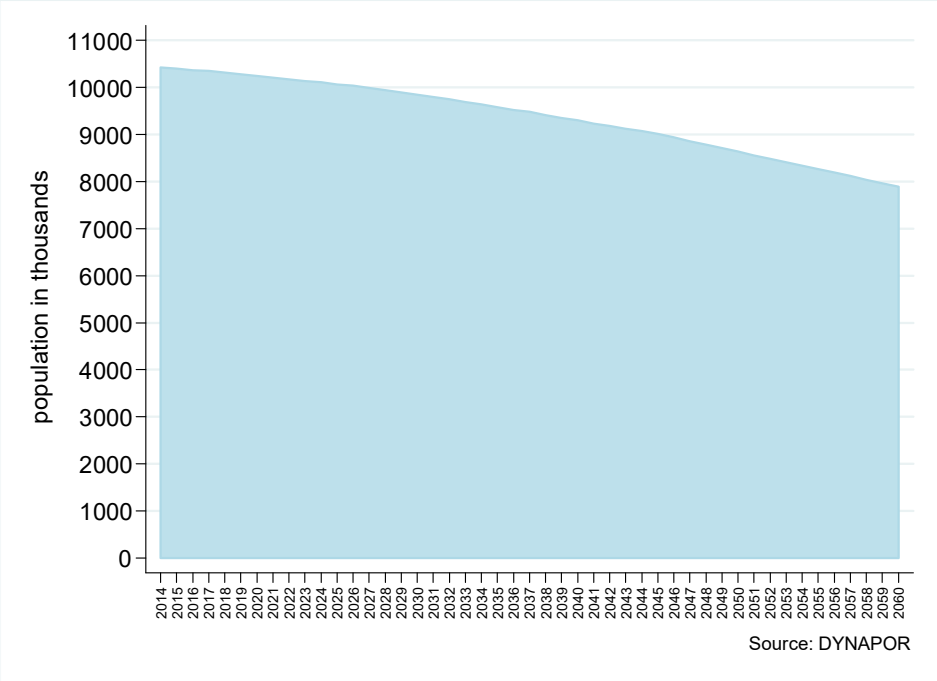


Table 15 Total Population projection in thousands, 2015-2060

	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
Total Population	10400	10300	10100	9832	9594	9311	8982	8630	8229	7871

Source: DYNAPOR projections

The relative share of age-groups adds to the previous in the sense that, in 2015, the share of young individuals aged 0 to 14 years old is expected to account for 14.5 percent, the population considered to be of working age (15 to 64 years old) is expected to account for 65.4 percent and finally, the older persons population is expected to account for 20.1 percent. Assuming the steady decline shown in Figure 23, the age structure of the population changes considerably by 2060, exhibiting the characteristic changes associated with demographic ageing, i.e. a decrease in the share of young and

working population and an increase in the share of the elderly. As shown in *Figure 24*, by 2060, the share of young individuals is expected to account for 10.9 percent of the total population, while the working age population is expected to account for 52.7 percent. In turn, the older persons population is expected to account for 36.4 percent of the total population, a considerable increase from the 20.1 percent verified in 2015.

Figure 24 Age structure projection, 2015-2060

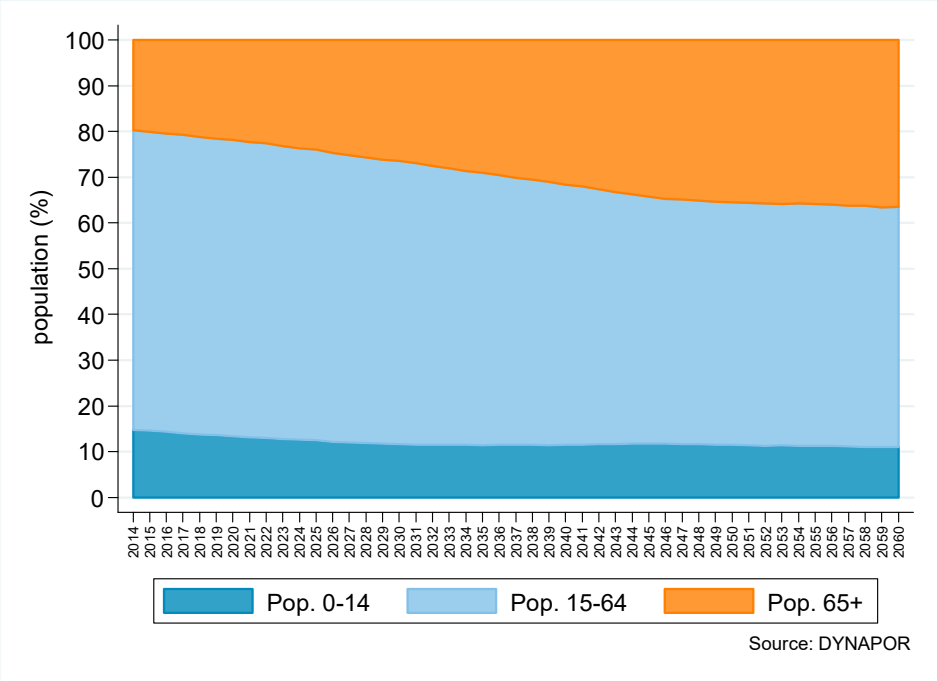


Table 16 Age structure projection, 2015-2060

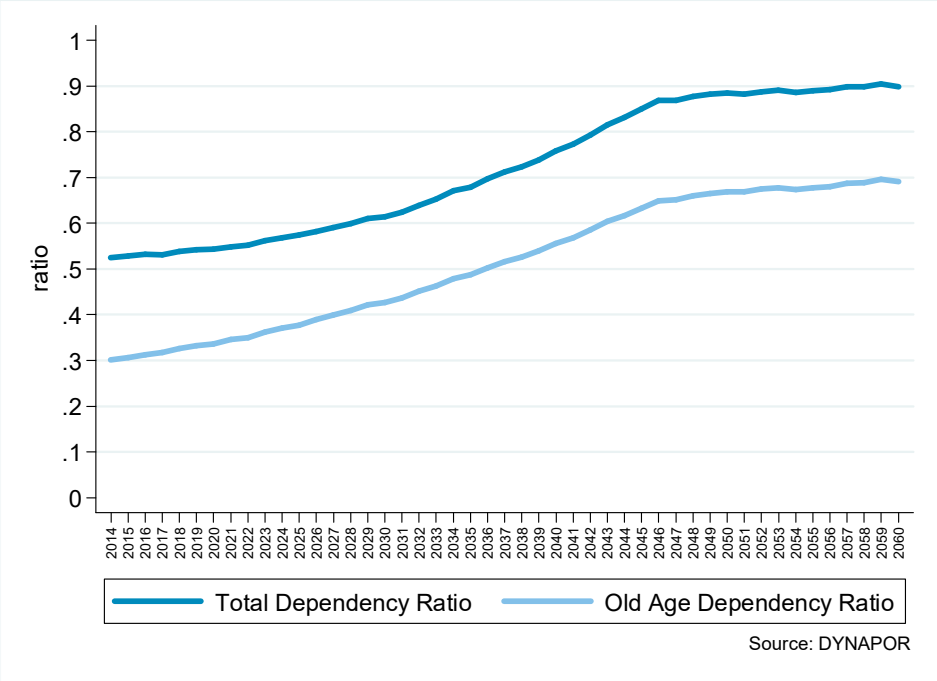
	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
0-14 yrs	1508857	1358641	1237745	1152299	1105790	1066168	1014422	976913.4	907256	851834.8
15-64 yrs	6806039	6660118	6407391	6105797	5722225	5290414	4864474	4578407	4331261	4114371
65+ yrs	2089698	2237808	2406256	2574301	2766354	2954765	3103133	3074950	2990461	2904526

Source: DYNAPOR projections

Consequently, due to the increase in the share of the older population in relation to the total population between the period from 2015 to 2060, there is an expected aggravation of the old age dependency ratio. According to the simulation results, in 2015, we are expected to have 31 persons aged 65 and over per 100 individuals in working age. Following the expected increase in the share of

the older population, the old age dependency ratio is expected to increase to 69 older individuals per 100 individuals in working age by 2060, which represents an increase of 125%. In comparison, the EU28 projections estimate an old age dependency ratio of 60%, i.e. 10 individuals less than the results of this model.

Figure 25 Old age and Total Depedency Ratio projections, 2015-2060



Finally, the total dependency ratio, i.e. the ratio of those aged 0-14 years old and 65 and older to those of working age (15-64), is expected to increase considerably (*Figure 25)*. The total-age-dependency ratio is the ratio of the sum of the number of young and the number of elderly people at an age when both groups are generally economically inactive, (i.e. under 15 years of age and aged 65 and over), compared to the number of people of working age (i.e. 15-64 years old)' (Eurostat, 2017). In this report the value is expressed per 100 persons of working age. In 2015, there is an expected 53 individuals out of working age for every 100 individuals working age, while in 2060, this number reaches a staggering 90 to 100 ratio. This means that for every 10 individuals of working age, there are 9 individuals that are not. This shows an expected increase in the demographic pressure to be placed in the working age population throughout the simulation.

7.2. Labour Market Dynamics

Although the demographic results of the simulation is the same for all scenarios considered, for the remainder of this analysis that is no longer the case. Consequently, each Figure will be composed by each one of the 5 scenarios simulated and analysed comparatively. The labour force (or active population), includes both employed (employees and self-employed) and unemployed people, but not the economically inactive' (Eurostat, 2017). In this simulation, the labour force relates to the active population aged 15-64 years old. As show in *Figure 26* all scenarios show an expected decline in the labour force as well as the active population. Although there is a decline in both the labour force and the working age population, in terms of composition, the proportion of the labour force in the active population actually increases considerably in all scenarios. Further, the differences between scenarios are mostly negligible. The baseline scenario shows an expected decrease in the labour force of 31%, from 4.83 million individuals in 2015 to 3.33 million in 2060. Scenarios 1 and 2 show a decline of 31.8 percent, the largest decrease in the labour force of all the scenarios, going from 4.82 million individuals in 2015 to 3.28 million in 2060. Scenarios 1 and 2 are followed by scenario 3 with a decrease of 31.6 percent, going from 4.81 million individuals in 2015 to 3.29 million in 2060. Finally, scenario 4 shows a decline of 31.4 percent, the smallest in all the NDC scenarios, going from 4.81 million individuals in 2015 to 3.30 million in 2060. These difference between scenarios may be explained by the option-value model that is used to simulate the retirement transition. Additionally, the decline in the working age population is more accentuated in the *baseline scenario* (39.5 percent) than in the remaining scenarios (38.9 percent). Overall, there is an expected decrease of approximately 31% in the labour force for all the scenarios accompanied by an expected decrease of approximately 40% in the working age population.

Figure 26 Working population (aged 15-64 years old) projections, 2015-2060

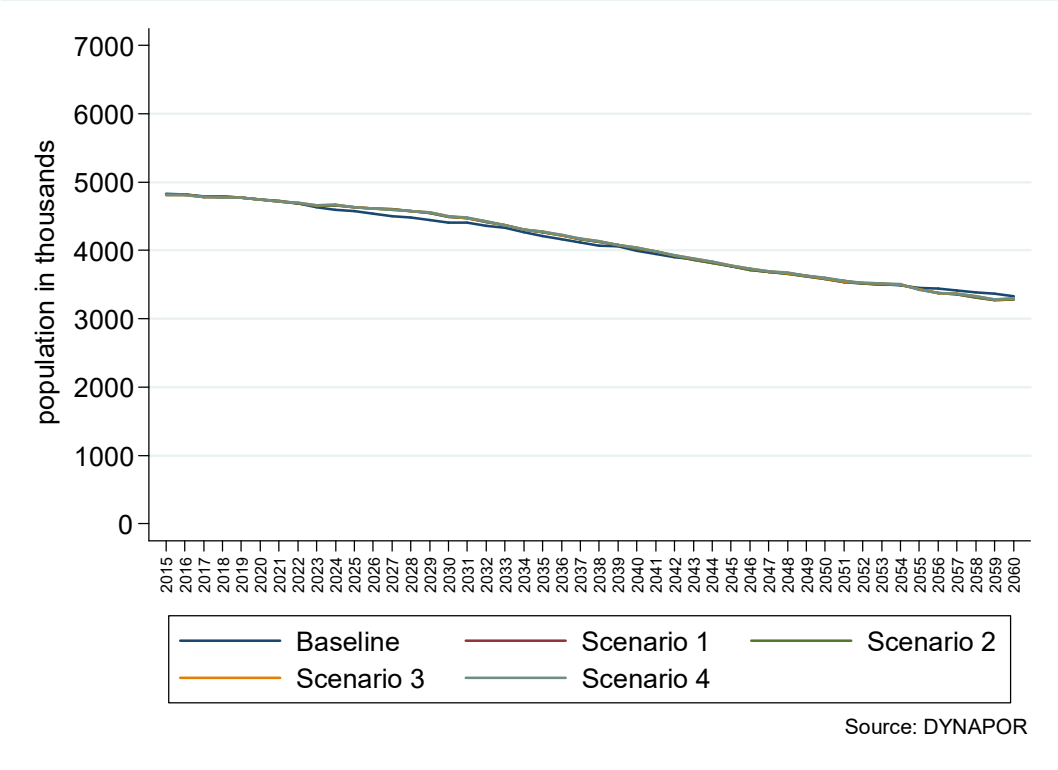


Table 17 Working Population (aged 15-64 years old) projections in thousands, 2015-2060

Scenario	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
Baseline	4825.702	4748.259	4579.983	4407.375	4211.154	3990.483	3773.003	3589.144	3452.064	3331.284
Scenario 1	4818.055	4749.063	4631.817	4491.374	4270.905	4026.895	3770.437	3582.238	3429.525	3284.102
Scenario 2	4818.055	4749.063	4631.817	4491.374	4270.905	4026.895	3770.437	3582.238	3429.525	3284.102
Scenario 3	4808.727	4745	4631.357	4505.792	4273.419	4041.674	3776.751	3591.397	3432.965	3288.133
Scenario 4	4808.727	4745	4631.357	4500.675	4273.084	4039.405	3780.206	3597.802	3428.102	3299.064

Source: DYNAPOR projections

Since the decrease in the working age population happens at a faster pace than the decrease in the labour force, it actually translates into a higher participation rate. In fact, all scenarios display an improvement in the participation rate (*Figure 27)*, with the best performance found in the baseline scenario, which increases from 70.82 percent to 79.8 percent (corresponding to an increase of 12.7 percent) between 2015 and 2060, followed by *Scenario 4*, which shows an expected increase from 70.56 percent in 2015 to 78.42 percent in 2060 (corresponding to an increase of 11.11 percent), *Scenario 3* going from 70.56 percent in 2015 to 78.13 percent in 2060 (corresponding to an increase

of 10.7 percent), and finally, scenarios 1 and 2, with an increase going from 70.7 percent in 2015 to 78.07 percent in 2060 (corresponding to an increase of 10.4 percent). Finally, all scenarios show a participation rate that is higher for men than for women. Although not represented here graphically, this information can be found in scenario tables in Appendix section.

Figure 27 Participation Rate projections, 2015-2060

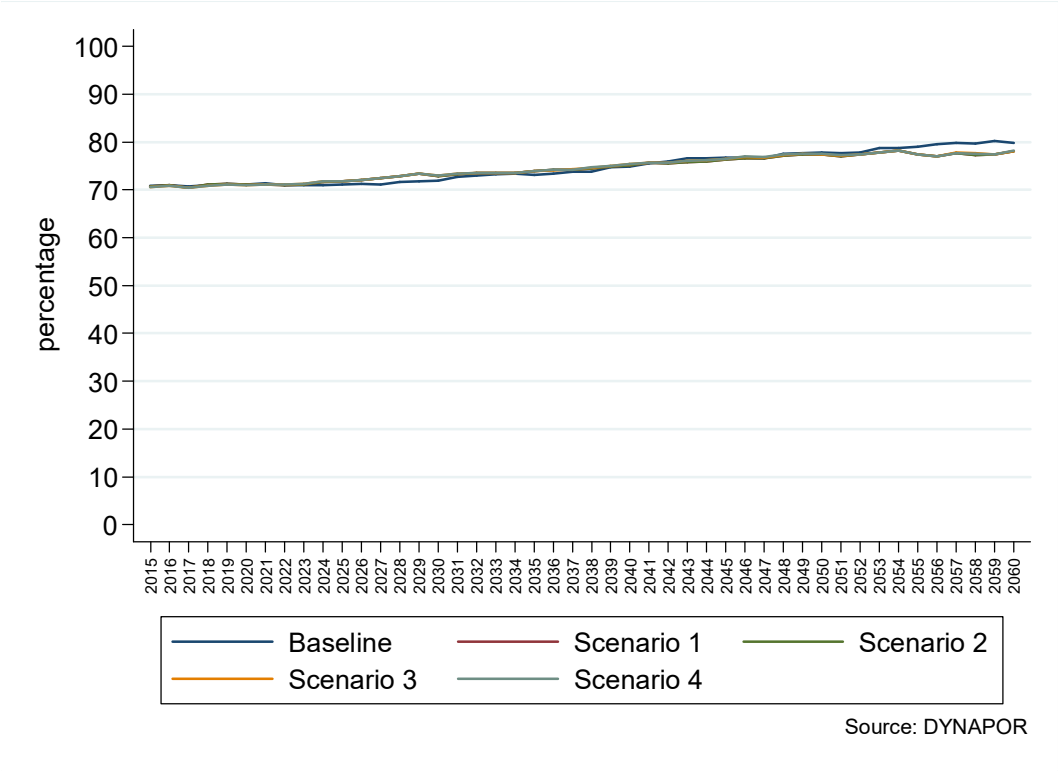


Table 18 Participation Rate projections, 2015-2060

Scenario	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
Baseline	70.82253	71.16019	71.18665	71.89313	73.19054	74.90897	76.76368	77.80383	78.97668	79.80144
Scenario 1	70.6993	71.07446	71.77664	72.84614	73.94434	75.18707	76.32121	77.38244	77.45326	78.06618
Scenario 2	70.6993	71.07446	71.77664	72.84614	73.94434	75.18707	76.32121	77.38244	77.45326	78.06618
Scenario 3	70.56452	71.0489	71.75497	73.05401	73.94526	75.40194	76.43496	77.39027	77.4585	78.13062
Scenario 4	70.56452	71.0489	71.75497	72.97504	73.9277	75.37796	76.47644	77.49819	77.37914	78.2664

Source: DYNAPOR projections

As expected, an increase in the participation rate is accompanied by changes in the employment and unemployment rate. Regarding the expected employment rate (*Figure 28*), all scenarios show a dramatic improvement, again with the baseline scenario performing the best, showcasing an increase

of 24.1 percent (from 59.97 percent in 2015 to 74.4 percent in 2060), followed by *Scenario 4* with an increase of 22.2 percent (from 59.54 percent in 2015 to 72.73 percent in 2060), *Scenario 3* with an increase of 21.7 percent (from 59.54 in 2015 to 72.47 percent in 2060), and, at last, *Scenarios 1 and 2* with an expected increase of 21.4 percent (from 59.67 in 2015 to 72.44 in 2060). Clearly, difference in the employment rate performance reflects the different scenario performances in the participation rate. Again the gender differences in the employment rate appear to be in favour of males. Additionally, it is noteworthy that although the baseline scenario performs the best when comparing 2015 and 2060, for the most part of the simulation, it actually performs the worst, only surpassing the NDC scenarios around 2051.

Figure 28 Employment Rate projections, 2015-2060

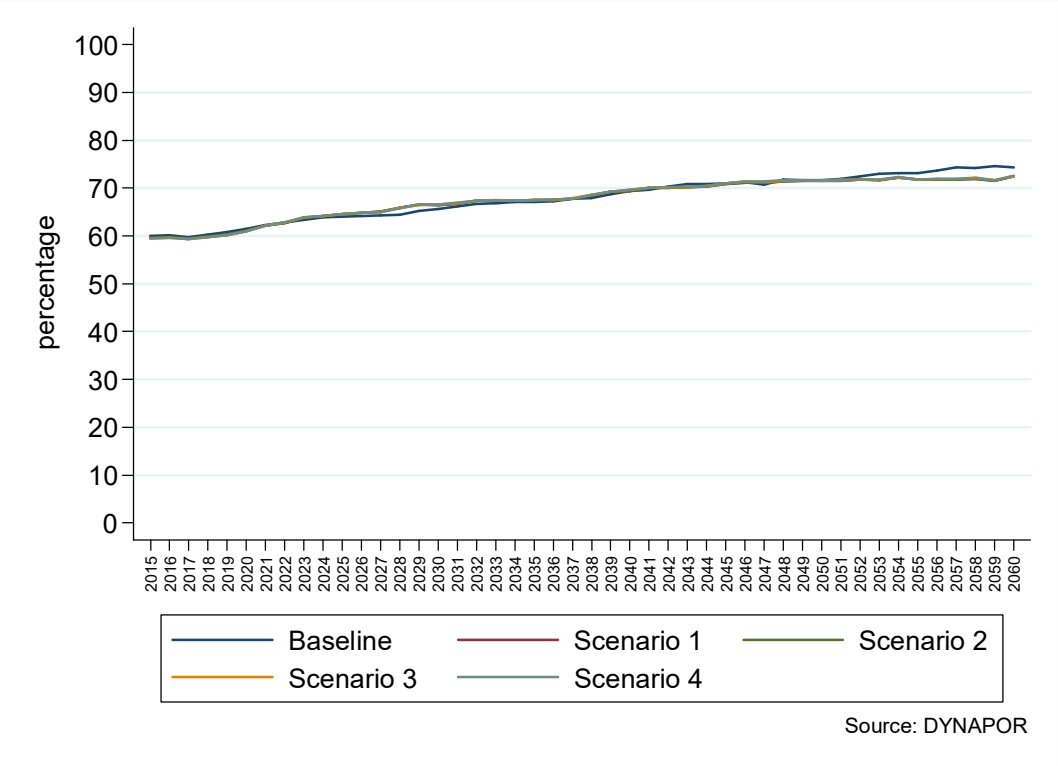


Table 19 Employment Rate projections, 2015-2060

Scenario	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
Baseline	59.96806	61.46144	64.03958	65.58403	67.13715	69.37287	70.98193	71.7109	73.1092	74.40306
Scenario 1	59.66957	61.0253	64.56382	66.40512	67.52939	69.44051	70.897	71.56362	71.82595	72.44357
Scenario 2	59.66957	61.0253	64.56382	66.40512	67.52939	69.44051	70.897	71.56362	71.82595	72.44357
Scenario 3	59.53772	60.99643	64.56781	66.57982	67.54241	69.65327	70.98088	71.59554	71.85498	72.46577

Scenario 4	59.53772	60.99643	64.56781	66.51518	67.53028	69.63725	70.98947	71.6917	71.78352	72.58974

Source: DYNAPOR projections

Consequently, due to the increase in the employment rates, the simulation results estimate a decrease in the expected unemployment rates (*Figure 29*. In line with the previous observations, the baseline scenario has the best performance in term of unemployment rate, with an expected decline of 50.3 percent (from 10.85 to 5.4 percent between 2015 and 2060), followed by: *Scenarios 1 and 2*, which show an expected decline of 49 percent (from 11.03 in 2015 to 5.62 in 2060), *Scenario 3* with an expected decline of 48.6 percent (from 11.03 percent in 2015 to 5.66 in 2060), and, finally, *Scenario 4* with an expected decline of 48.5 percent (from 11.03 percent in 2015 to 5.68 in 2060).

Figure 29 Unemployment Rate projections, 2015-2060

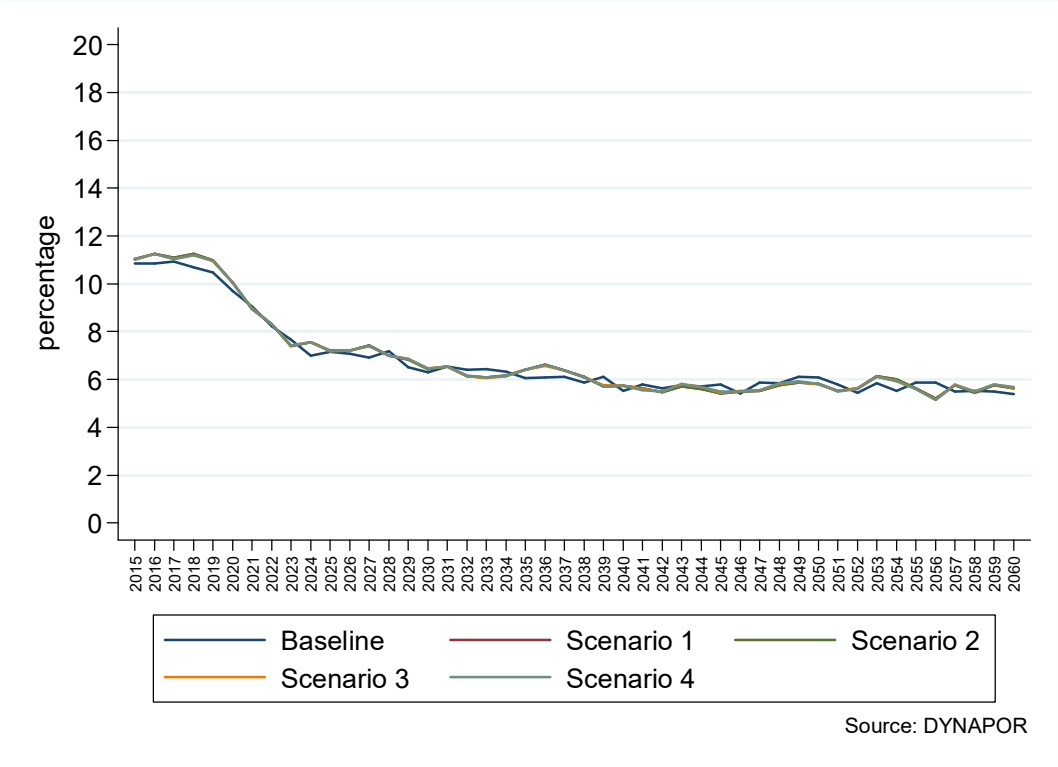


Table 20 Unemployment Rate projections, 2015-2060

Scenario	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
Baseline	10.854	9.699	7.147	6.309	6.053	5.536	5.782	6.093	5.867	5.398
Scenario 1	11.030	10.049	7.213	6.441	6.415	5.747	5.424	5.819	5.627	5.623
Scenario 2	11.030	10.049	7.213	6.441	6.415	5.747	5.424	5.819	5.627	5.623

Scenario 3	11.027	10.052	7.187	6.474	6.403	5.749	5.454	5.795	5.604	5.665
Scenario 4	11.027	10.052	7.187	6.460	6.397	5.741	5.487	5.806	5.596	5.677

Source: DYNAPOR projections

Finally, as a consequence of demographic ageing, the average age of the labour force increases in all the scenarios. The sharpest increase in the average age of the labour force is found in baseline scenario, which is expected to increase from 41.5 years old in 2015 to 43.2 years old in 2060 (4.1 percent increase), followed by Scenario 4, which is expected to increase from 41.44 to 42.97 years old (3.7 percent increase), *Scenario 3*, which shows an expected increase from 41.44 to 42.65 years old (3.6 percent increase) and *Scenarios 1 and 2* show an expected increase from 41.47 to 42.93 years old (3.5 percent increase). Overall, in spite of the decrease in the working age population and the labour force, there is an expected improvement in the participation rate and, hence, in the employment and unemployment rates. Although there are small differences, all scenarios show similar results and the differences between them appear to be negligible.

7.3. Prospective Demand for Pensions

This section follows by providing a comparative analysis of the demand for old age pensions, i.e. the number of pensioners. As shown in *Figure 30*, there is an overall increase in the demand for pensions for all scenarios between 2015 and 2050, represented by an increase in the total number of pensioners. From then until 2060, either the total number of pensioners stabilizes or it decreases slightly. Here, the total number of pensioners is determined by the sum of old age pensioners, early retired pensioners, early retired by long duration unemployment (LDU) pensioners and, where applicable, Notional-Defined Contribution pensioners. Comparatively, the expected total number of pensioners in the baseline scenario appears to increase at a faster pace than the other scenarios, with an expected increase of 46.3 percent in total number of old age pensioners, from 1.89 million in 2015 to 2.77 million in 2060. Comparatively, the remaining scenarios show an expected increase of 43.7 percent in *Scenarios 1 and 2* (from 1.86 million in 2015 to 2.68 million in 2060), 41.9 percent in

Scenario 3 (from 1.88 million in 2015 to 2.67 million in 2060) and 41.7 percent in Scenario 4 (from 1.88 million on 2015 to 2.66 million in 2060). The differences shown in the NDC scenarios are most likely due to the introduction of redistributive measures and the automatic balance mechanism. Due to the automatic balance mechanism, in Scenario 4, notional accounts grow at a slower pace since indexation may sometimes be made to the balance ratio instead of the income index. Consequently, the value of retiring at a given age decreases in comparison to scenarios 1, 2 and 3. Overall, these results reflect the expected increase in number of the elderly associated with expected demographic projections. Additionally, it is important to note that the differences in scenarios 1, 2 and 3 are once again negligible and that the introduction of redistributive measures and an automatic balance mechanism does not appear to produce a significate effect on the decision to retire.

Figure 30 Pension Demand: total number of pensioners projection, 2015-2060

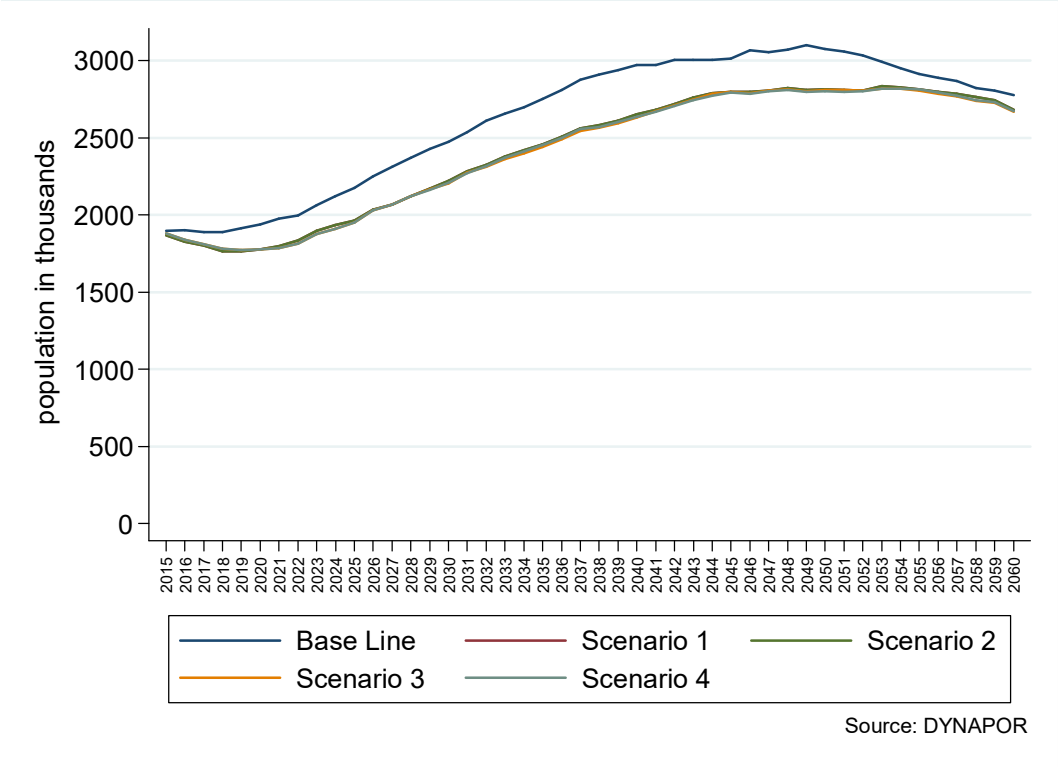


Table 21 Pension Demand: total number of pensioners projection in thousands, 2015-2060

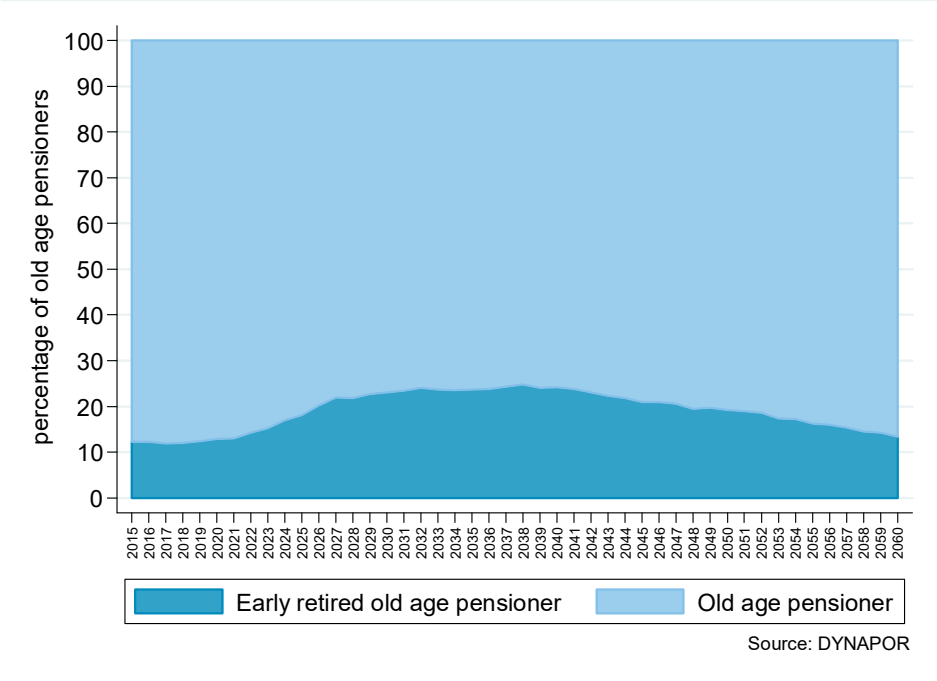
Scenario	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
Baseline	1896.802	1940.477	2174.944	2472.927	2750.667	2969.704	3012.138	3074.079	2912.147	2774.805
Scenario 1	1866.188	1775.917	1963.402	2218.584	2458.031	2650.064	2796.258	2814.01	2813.554	2682.01
Scenario 2	1866.188	1775.917	1963.402	2218.584	2458.031	2650.064	2796.258	2814.01	2813.554	2682.01

Scenario 3	1880.251	1777.066	1951.689	2204.869	2440.743	2630.462	2796.129	2809.285	2803.987	2667.884
Scenario 4	1880.251	1777.066	1951.689	2207.286	2451.669	2633.946	2791.227	2799.18	2812.731	2671.66

Source: DYNAPOR projections

The remainder of this section will analyse the composition of the old age pensioners by type of pension for each of the scenarios. As show in *Figure 31* the baseline scenario shows an expected increase in the share of early retired pensioners between 2015 and 2040, from 12.1 to 24.19 percent. From this point onward, the share of early retired individuals begins to decrease reaching a final value of 13.4 percent in 2060.

Figure 31 Old age pensioners composition projections (Base line scenario), 2015-2060



For the remaining scenarios, aside from showing the proportions of old age pensioners by type of pension, it is also possible to analyse the transition speed, as the tradition DB-PAYG pensioners get replaced by the new NDC pensioners, until the number of the first is negligible when compared with the latter. As show in Figure 32, the relative share of pensioners is very similar in the remaining 3 scenarios. This shows that in spite of the redistributive or automatic balance mechanisms, the speed of transition remains relatively unaffected. Each of the scenarios shows a fast decrease in the relative

share of old age pensioners of the traditional DB-PAYG scheme and a relatively stable number of early retired individuals (early retired + early retired by long duration unemployment). In fact, the speed of transition is so fast that in all scenarios, by 2030, the number of pensioners in the NDC pension system already outweighs the number of pensioners in the DB system.

Figure 32 Old age pensioners composition projections (NDC scenarios), 2015-2060

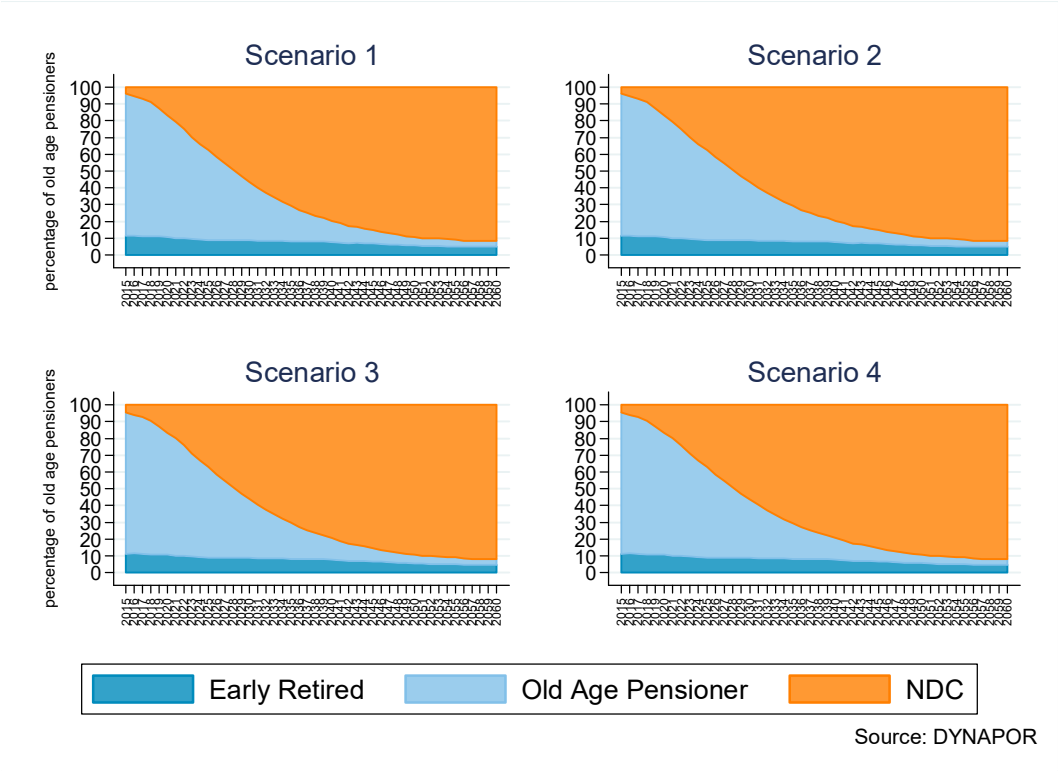


Table 22 Old age pensioner composition projections (NDC scenarios), 2015-2060

Scenario	Pension Type	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
Scenario 1	NDC	71886.5	296545.7	735893.7	1253775.0	1735281.0	2111604.0	2385863.0	2512164.0	2552953.0	2459097.0
	OAP	1583149.0	1291786.0	1052580.0	773247.2	523034.6	339213.1	223523.5	143399.4	118381.7	91362.6
	OAP ER	211153.2	187585.9	174928.7	191561.3	199715.5	199246.9	186872.1	158446.0	142218.9	131550.6
Scenario 2	NDC	71886.5	296545.7	735893.7	1253775.0	1735281.0	2111604.0	2385863.0	2512164.0	2552953.0	2459097.0
	OAP	1583149.0	1291786.0	1052580.0	773247.2	523034.6	339213.1	223523.5	143399.4	118381.7	91362.6
	OAP ER	211153.2	187585.9	174928.7	191561.3	199715.5	199246.9	186872.1	158446.0	142218.9	131550.6
Scenario 3	NDC	85949.5	297694.6	724180.1	1240061.0	1717993.0	2092002.0	2388881.0	2510306.0	2550334.0	2453792.0
	OAP	1583149.0	1291786.0	1052580.0	773247.2	523034.6	339213.1	223523.5	143399.4	114991.0	87550.0
	OAP ER	211153.2	187585.9	174928.7	191561.3	199715.5	199246.9	183724.4	155580.3	138662.9	126541.8
Scenario 4	NDC	85949.5	297694.6	724180.1	1242477.0	1728919.0	2095486.0	2383979.0	2500200.0	2559077.0	2457568.0
	OAP	1583149.0	1291786.0	1052580.0	773247.2	523034.6	339213.1	223523.5	143399.4	114991.0	87550.0
	OAP ER	211153.2	187585.9	174928.7	191561.3	199715.5	199246.9	183724.4	155580.3	138662.9	126541.8

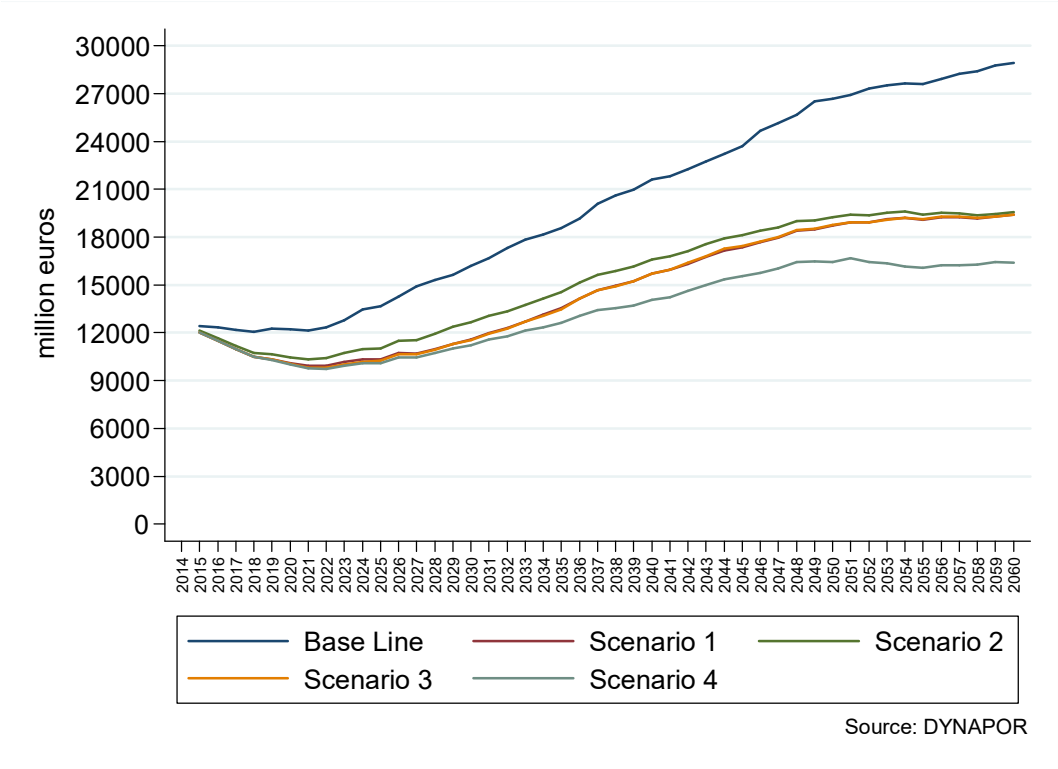
Source: DYNAPOR projections

7.4. Prospective Pension Expenditure

The following section analyses the prospective expenditure with old age pensions in a comparative framework. Each of the scenarios is analysed in terms of total expenditure and expenditure by pension type. As shown in *Figure 33,* there is an overall increase in old age pension expenditure in all scenarios between 2015 and 2060. Old age pension expenditure, here, is considered to be the sum of old age pension expenditure, early retired pension expenditure, early retired for long duration unemployment expenditure and NDC old age pension expenditure where applicable. Comparatively, the baseline scenario increases considerably more than the remaining scenarios. According to the simulation results, there is an expected increase in old age pension expenditure of 133.2 percent in the baseline scenario, increasing from 12 384 million euros in 2015 to 28 875 million euros in 2060. Comparatively, the remaining scenarios show the most interesting results. Overall all of the NDC scenarios show an increase in pension expenditure. In *Scenario 1*, there is an expected increase of 62.6 percent in total old age pension expenditure, from 11 979 million euros in 2015 to 19 477 million euros in 2060. Similarly, *Scenario 2* shows an expected increase of 61.8 percent in total pension expenditure, from 12 100 million euros in 2015 to 19 577 million euros in 2060, while *Scenario 3* shows an expected

increase of 61.4 percent in total expenditure with old age pensions, from 12 038 million euros in 2015 to 19 429 million euros in 2060. Finally, due to the automatic balance mechanism, the Scenario 4 shows the most contained increase, going from 12 038 million euros in 2015 to 16 380 euros in 2060, representing an increase of 36.1 percent. The effect of the automatic balance mechanism is striking in the last scenario, curbing pension expenditure by approximately half of what it has increased for the other NDC scenarios.

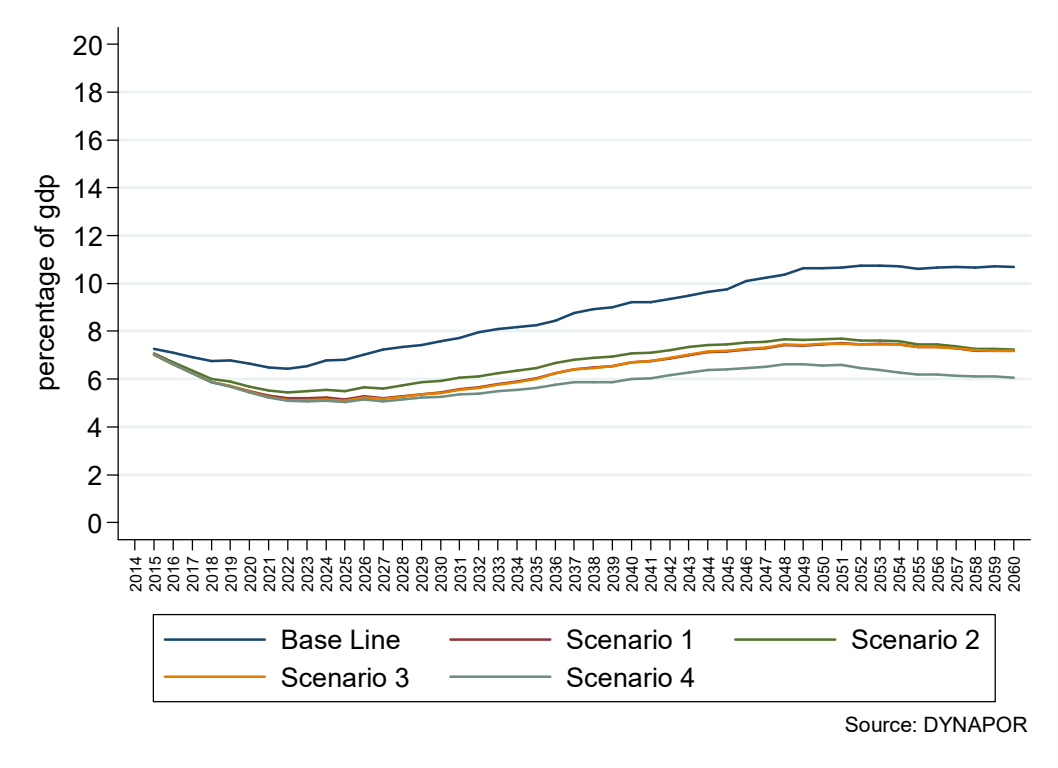
Figure 33 Total expenditure with pensions projection, 2015-2060



Another striking result from this simulation is that for all scenarios, although total expenditure with old age pension increases considerably in total amount, when analysed as percentage of GDP (*Figure 34*), this increase does not seem proportional. This is because GDP increases 157 percent between 2015 and 2060. It is important to note that GDP is not estimated in this model. Instead, GDP is an exogenous parameter that is given by the Ageing Report 2015 projections (see Chapter 4 for a more thorough description of the assumptions behind the DYNAPOR model). Consequently, although there

is a slight increase in total expenditure as percentage of GDP, said increase is nowhere near what could be expected if the GDP assumptions were not as positive as the ones adopted in this model.

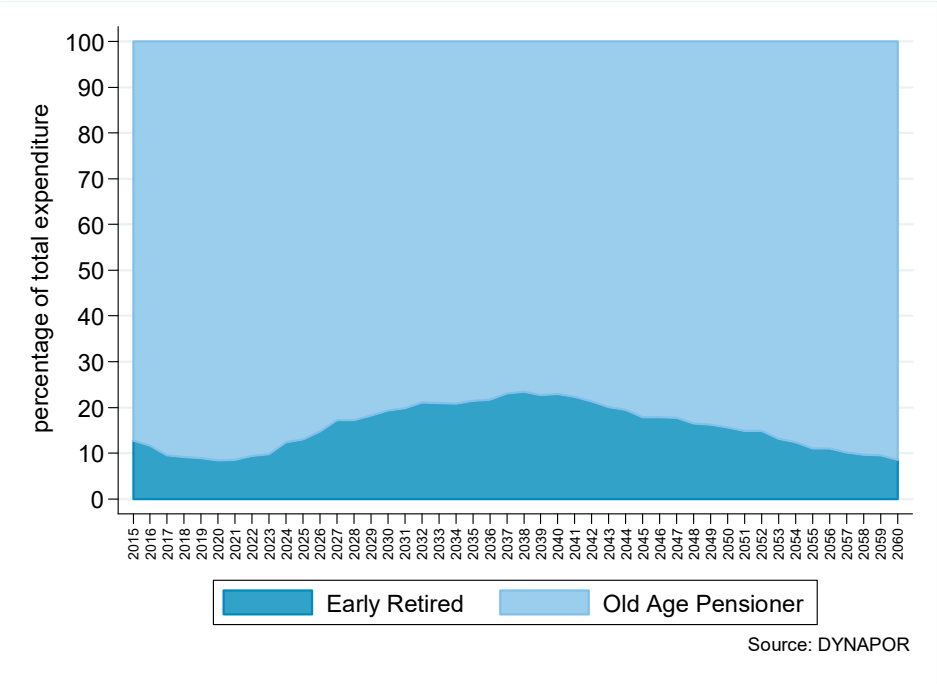
Figure 34 Total expenditure with pensions as a percentage of GDP projection, 2015-2060



A surprising result that is important to take into account is the fact that although the introduction of a minimum guaranteed pension may increase pension expenditure at the beginning of the transition to the NDC, at the end of the simulation, pension expenditure for scenarios 1 and 2 is the same. This means while the introduction of a minimum guaranteed pension at the beginning of the transition to the new NDC system for a short adaptation period may result in an additional burden for the transition period, it does not produce a long term effect as individuals appear to adapt their behaviour and plan their retirement accordingly. Finally, these results clearly highlight the importance of the automatic balance mechanism in curbing pension expenditure. When comparing scenarios 1, 2 and 3 with Scenario 4, the increase in expenditure is a lot smaller in the latter. The difference in expenditure between the scenarios is almost 16 percent, representing a staggering 3 111 million euros.

The remainder of this section provides composition analysis of old age pension expenditure, exploring the relative share of expenditure according to total old age pension expenditure. As expected, in the baseline scenario, expenditure by type of pension accompanies the change in the composition of pensioners presented in the previously. As shown in *Figure 35*, there is an increase in the proportion of expenditure with early retirement pensions from 13 percent of total old age pension expenditure in 2015 to 23 percent in 2040. Similarly to the number of pensioners, from this point onward, the relative share of expenditure with early retirement pensions begins to decrease, reaching 9 percent in 2060. It is important to note that, in spite of the initial increase, the share of expenditure with early retirement is actually smaller in 2060 when compared to 2015.

Figure 35 Pension expenditure composition by type of pension projection (Base line), 2015-2060



Again, for the remaining scenarios, aside from showing the proportions of pension expenditure by type of pension, it is also possible to analyse the transition speed, as expenditure with DB-PAYG pensions gets replaced with NDC expenditure. As shown in Figure 36, it appears that expenditure in the first scenario seems to grow at a slower pace in first few years when compared with scenarios 2, 3 and 4. Again, this is the result of the introduction of the minimum guaranteed pension, which

increases relative share of total expenditure with NDC pensions at a faster pace in scenarios 2, 3 and 4. On the other hand, it appears that the automatic balance mechanism does not have a very pronounced effect on the distribution of old age pension expenditure between the DB and the NDC pension system. This is probably the result of the fast transition as the number of pensioners in the NDC pension system quickly surpasses the total number of pensioners in the DB pension system.

Figure 36 Pension expenditure composition by type of pension projection (NDC Scenarios), 2015-2060

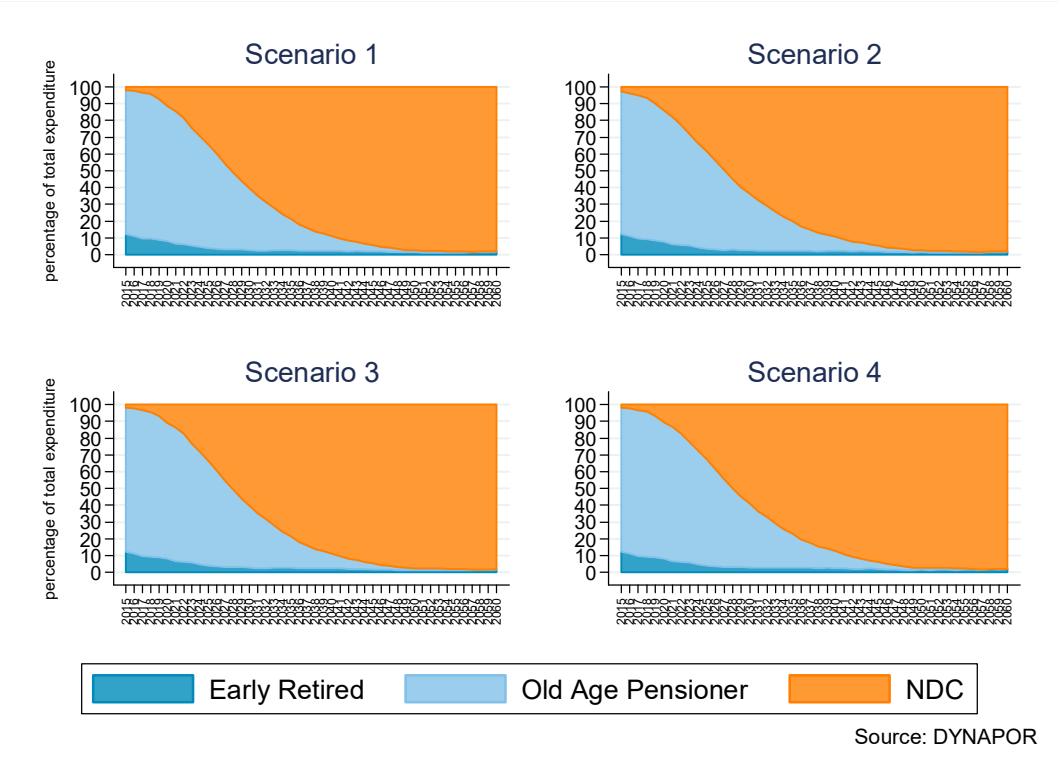


Table 23 Pension expenditure composition by type of pension projection (NDC Scenarios) in millions of euros, 2015-2060

Scenario	Pension Type	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
Scenario 1	NDC	202	1130	3530	7000	10600	14000	16400	18200	18800	19100
	OAP	10300	8180	6430	4270	2540	1410	668	236	118	16
	OAP ER	1477	789	377	321	346	350	312	253	210	361
Scenario 2	NDC	323.0	1490.0	4230.0	8060.0	11600.0	14800.0	17100.0	18800.0	19100.0	19200.0
	OAP	10300.0	8180.0	6430.0	4270.0	2540.0	1410.0	668.0	236.0	118.0	16.3
	OAP ER	1477.0	789.0	376.5	320.8	346.0	349.7	312.0	253.0	210.0	361.0
Scenario 3	NDC	223.0	1090.0	3440.0	6950.0	10600.0	14000.0	16500.0	18300.0	18800.0	19100.0
	OAP	10300.0	8180.0	6430.0	4270.0	2540.0	1410.0	671.0	235.0	119.0	16.3
	OAP ER	1477.0	789.0	376.5	320.8	347.0	349.7	277.0	228.0	228.0	330.0
Scenario 4	NDC	223.0	1060.0	3300.0	6640.0	9750.0	12300.0	14600.0	16000.0	15700.0	16000.0
	OAP	10300.0	8180.0	6430.0	4270.0	2540.0	1410.0	671.0	235.0	119.0	16.3
	OAP ER	1477.0	789.0	376.5	320.8	348.0	350.7	277.0	226.0	227.0	326.0

Source: DYNAPOR projections

7.5. Prospective Financial Sustainability

This section analyses the prospective financial sustainability of the pension system for each of the scenarios. Having looked at the expenditure of the pension system, this section begins by analysing the contributions made to system in order to determine the balance of the system. Before proceeding with this analysis, it is important to note that, as demonstrated bellow, there are different ways in which the number of contributions to the Social Security Pension system may be measured. This means that the financial assessment of the sustainability of the Social Security Pension System will depend on what is accounted as contributions to the system. In line with this work, only contributions destined to the old age pension system will be considered in this assessment. The primary objective of this exercise is to assess the financial sustainability of the old age pension system and not the ability of the Portuguese Social Security to cover expenditure on old age pensions with other sources of revenue.

As shown in *Figure 37*, the total amount of contributions for the old age pension system increases considerably in all scenarios. The expected increase in the contribution is the highest in the base line scenario, which increases from 10 200 million euros in 2015 to 17 700 million euros in 2060, representing an increase of 73.5 percent, which reflects the changes in the employment rates.

Comparatively, in *Scenarios 1 and 2* contributions are expected to increase by 67.7 percent, from 10 041 million euros in 2015 to 16 835 million in 2060. Finally, in *Scenarios 3 and 4*, the total amount of contributions for old age pensions are expected to increase 66 percent, from 10 000 million euros in 2015 to 16 600 million in 2060.

Figure 37 Contributions to Pension System projection, 2015-2060

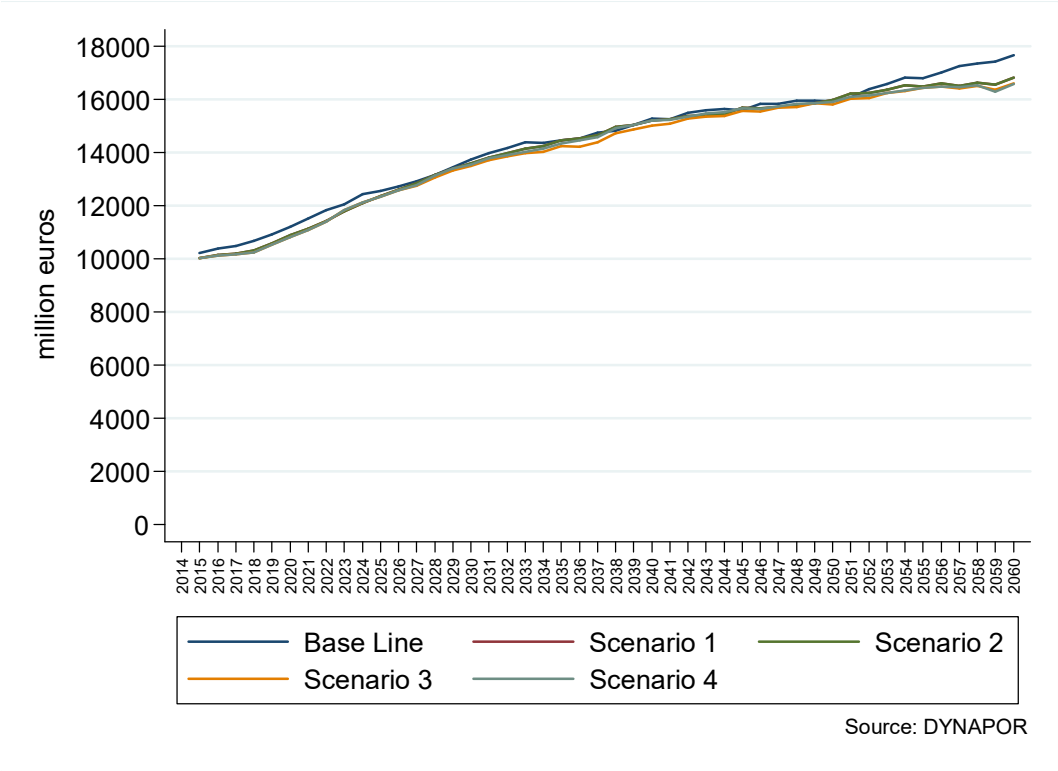


Table 24 Contributions to Pension System projection in millions of euros, 2015-2060

Scenario	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
Baseline	10217.9	11217.3	12570.9	13741.7	14467.7	15277.1	15610.2	15948.2	16799.1	17676.7
Scenario 1	10041.5	10895.9	12366.8	13596.1	14474.1	15202.8	15684.2	15993.3	16487.5	16834.9
Scenario 2	10041.5	10895.9	12366.8	13596.1	14474.1	15202.8	15684.2	15993.3	16487.5	16834.9
Scenario 3	10025.8	10815.6	12355.2	13502.9	14255.4	15014.4	15565.9	15816.5	16431.3	16606.8
Scenario 4	10025.8	10815.6	12355.2	13549.0	14343.6	15211.7	15664.0	15902.6	16432.9	16576.2

Source: DYNAPOR projections

Now, having assessed both the expected expenditure and contributions during the simulation period, it is possible to have a clearer picture of the financial sustainability of the pension system. The financial sustainability of the old age pension system is here defined as the difference between the

contributions for the old age pension system and the expenditure in old age pensions as previously defined in the prospective pension expenditure section. As shown in *Figure 38*, the baseline scenario displays the worst performance in terms of balance. Although there is a small improvement in the financial sustainability of the old age pension system in the first few years of the simulation, up to 2022, it quickly declines from then onward, leaping from -2 215 million euros to a staggering – 11 235 million euros, representing an increase of over fivefold in the deficit of the old age pension system. In comparison, the introduction of a NDC system clearly improves the expected financial sustainability of the pension system. As show in *Figure 38*, scenarios 1 and 2 perform relatively similarly, quickly running a surplus by 2030 of 2 012 million euros and 1 740 million euros respectively. However, as the simulation progresses, the financial sustainability of the system in scenarios 1 and 2 quickly worsens, reaching -2 595 million euros and -2 743 million euros in scenarios 1 and 2 respectively. Once again, the effect of the introduction of a transition guaranteed pension amount is evident in the financial sustainability of the system for the first few years. Again, while the effect of the introduction of a transition safeguard up to 2030 has an immediate effect in the first years of its introduction, it does not perpetuate through time and quickly gets diluted as the values for the financial sustainability of both scenarios converge by 2060. In scenario 3, the effect of the introduction of a minimum guaranteed pension along with the transition safeguard produces some effect for the first few years, however, it slowly gets diluted reaching a deficit of - 2 822 million euros in 2060, a value that is very close to the one in *Scenario 2*. Finally, the effect of the automatic balance mechanism is quite astonishing in comparison with the other scenarios. Similarly to scenarios 1, 2 and 3, in Scenario 4 there is an increase in the financial balance up to 2030, going from -2 096 million euros in deficit in 2015 to a surplus of 2 319 million euros in 2030. From then onward, the financial balance slowly decreases until it reaches zero in 2046. From 2046, the financial balance bounces upward and downward from zero until reaching a surplus of 196 million in 2060. Once again, this figure clearly illustrates the effect and the importance of the introduction of the automatic balance mechanism. As soon as the system is out of balance, the mechanism is triggered and the indexation of notional

accounts is dampened for as long as the system is out balance, resuming normal indexation once the balance is restore.

Figure 38 Financial Balance projection, 2015-2060

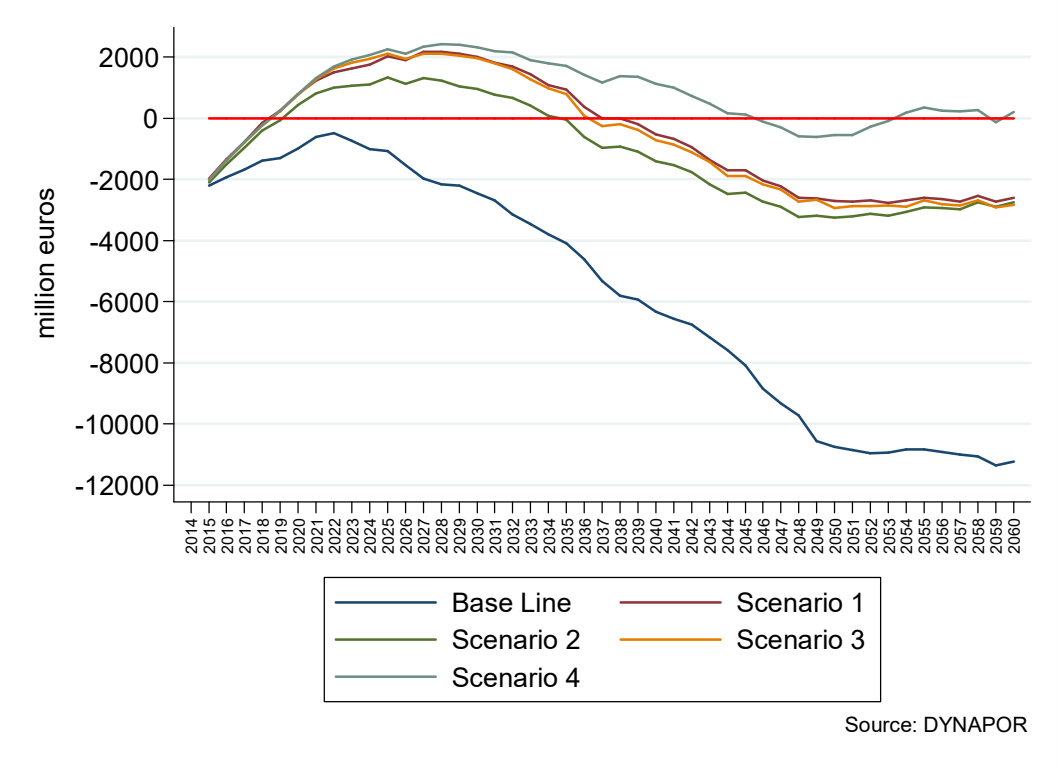


Table 25 Financial Balance projection in millions of euros, 2015-2060

Scenario	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
Baseline	-2214.924	-992.0086	-1079.238	-2446.962	-4091.763	-6325.227	-8081.673	-10744.63	-10819.12	-11235.13
Scenario 1	-1974.807	797.7722	2030.412	2011.815	941.3071	-521.7601	-1696.126	-2716.192	-2599.022	-2595.917
Scenario 2	-2096.028	440.0331	1334.715	949.5753	-57.29668	-1399.067	-2428.815	-3251.912	-2920.251	-2742.579
Scenario 3	-2012.211	757.9993	2109.829	1961.423	784.9286	-716.2141	-1892.628	-2935.797	-2679.593	-2822.142
Scenario 4	-2012.211	791.3792	2249.402	2319.16	1699.988	1130.861	113.1569	-550.9689	349.5491	196.2868

Source: DYNAPOR projections

Finally, *Figure 39* shows the expected financial balance as a percentage of GDP. These figures allow for the analysis of the deficit/surplus of the old age pension system as a percentage of GDP. While the previous indicator of financial sustainability may provide a good picture of how the system is developing in comparative terms, it is only when these figures are compared against the expected

evolution of GDP that it truly provides a clear image of the financial sustainability of the old age pension system.

Figure 39 Financial balance as a percentage of GDP projection, 2015-2060

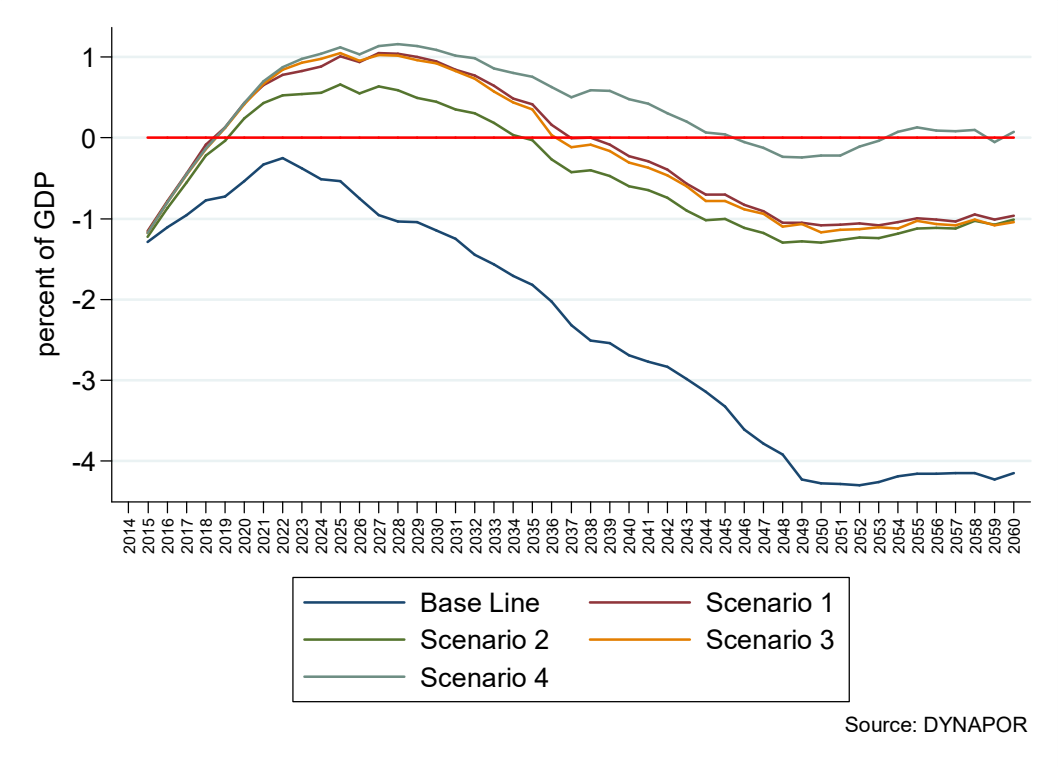


Table 26 Financial balance as a percentage of GDP projection, 2015-2060

Scenario	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
Baseline	-1.292939	-0.5396061	-0.5377968	-1.147829	-1.820958	-2.696496	-3.328672	-4.282199	-4.157702	-4.156929
Scenario 1	-1.152773	0.4339506	1.011777	0.9437088	0.41891	-0.2224306	-0.6985987	-1.08252	-0.9987832	-0.9604737
Scenario 2	-1.223534	0.2393573	0.6651036	0.44543	-0.0254987	-0.5964338	-1.000378	-1.296027	-1.122229	-1.014737
Scenario 3	-1.174607	0.412316	1.051352	0.9200709	0.3493169	-0.305328	-0.7795337	-1.170042	-1.029746	-1.044175
Scenario 4	-1.174607	0.4304731	1.120903	1.087879	0.7565458	0.4820952	0.046607	-0.2195849	0.1343289	0.0726249

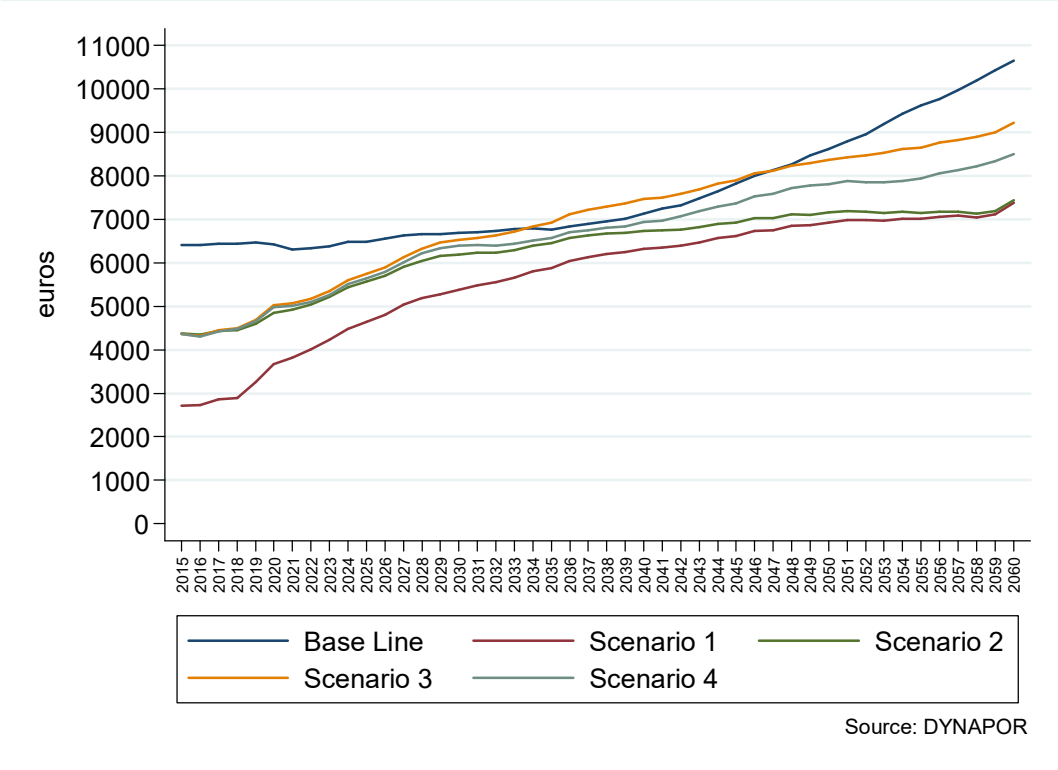
Source: DYNAPOR projections

7.6. Prospective Social Sustainability

This analytical section looks at how the Old Age Pension system is expected to perform in terms of its social sustainability. For this purpose, it begins by looking at how the expected average pension amount evolves throughout the simulation. As show in *Figure 40*, all scenarios display a considerable

expected increase in the average old age pension amount. The scenario that performs the best is the baseline scenario, with an expected increase in the average old age pension amount of 40.2 percent, increasing from 7 643 euros per year in 2015 to 10 699 euros in 2060. Among the NDC scenarios, as expected, *Scenario 1,* has the worst initial average pension amount of 2 707 euros per year in 2015 and it increases to 7 378 euros per year in 2060. While *Scenario 1* the average old age pension in Scenario 1 almost doubles, the lack of safeguards against low level pension is evident and clearly shows when compared to the remaining scenarios. In Scenario 2, the introduction of a transition safeguard of a gross replacement rate of at least 60 percent up until 2030 is evident in the average old age pension amount, which goes from 4 373 euros per year in 2015 to 7 437 euros in 2060, representing an increase of 70 percent. Again, the effect of the transition safeguard is evident, however, it slowly gets diluted throughout the simulation, displaying a converging trend in the average old age pension amount between *Scenarios 1 and 2*. One of the most interesting results in this section is the introduction of the minimum guaranteed pension amount of 24% of the average income of the previous year as simulated in *Scenario 3.* In this scenario, the average old age pension starts at 4 363 euros per year in 2015 and finishes at 9 226 euros in 2060, representing an increase of 114 percent in the average pension amount. One of the most striking aspects is that for a brief period (between 2033 and 2046), the average old age pension amount in *Scenario 3* actually surpasses the baseline scenario. Scenario 3 clearly shows the best performance and provides the highest average old age pension amount of all the NDC scenarios. Finally, *Scenario 4*, shows an increase going from 4 363 euros per year in 2015 to 8 507 euros in 2060, representing an increase of 95 percent. The impact of the automatic balance mechanism on the average old age pension amount is evident. Once again, the impact of the redistributive and automatic balance mechanism is evident.

Figure 40 Average old age pension amount projections (Total), 2015-2060



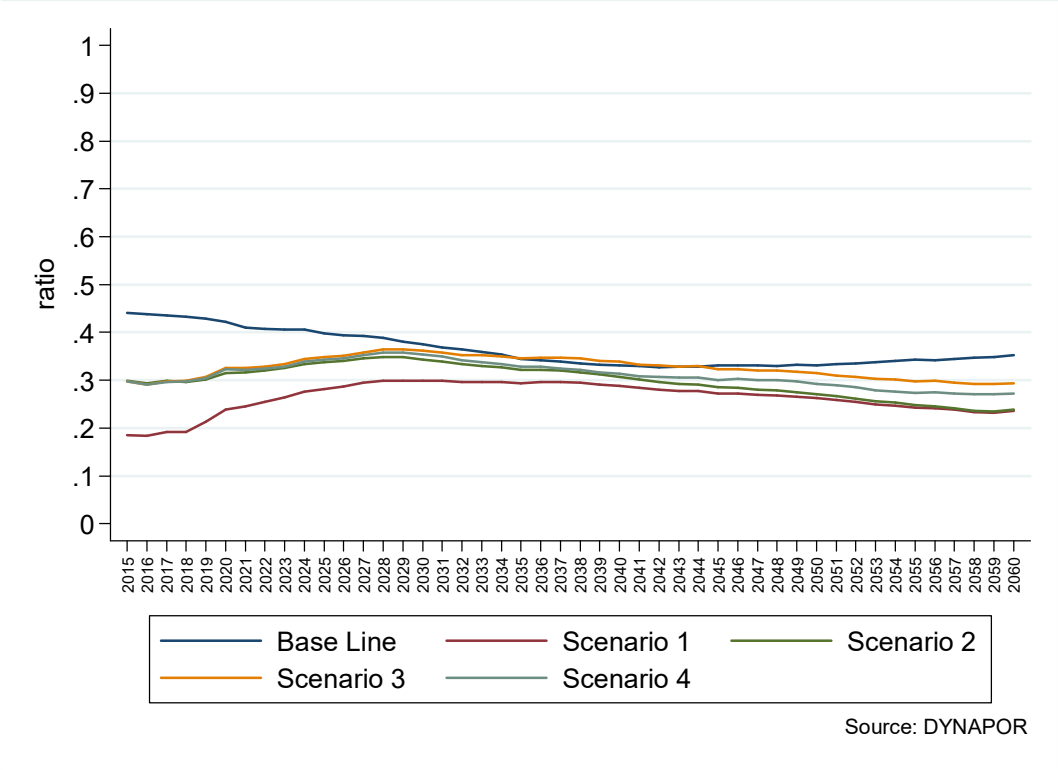
7.7. Prospective Adequacy

This section of this analysis is concerned with the ability of the pension system to provide a smooth economic transition into retirement. As a result, this section will focus of indicators that compare labour market earnings with pension income, such as the benefit ratio and the gross average replacement rate. The benefit ratio measures how the average pension compares with the average income in the labour market. On the other hand, the gross replacement rate measures how the individual's pension income compares with the last income he has received prior to retirement. While the first indicator provides a measure of the pensioners' position in the economy as a whole, the latter provides a comparison of how the individual pensioner fairs against his last economic standpoint prior to retirement, and therefore a clear indicator the consumption smoothing effect of the pension system.

As shown in Figure 41, the benefit ratio of all scenarios is expected to fall except for scenario 1, which unsurprisingly begins considerably lower than the rest. Once again, the difference in generosity

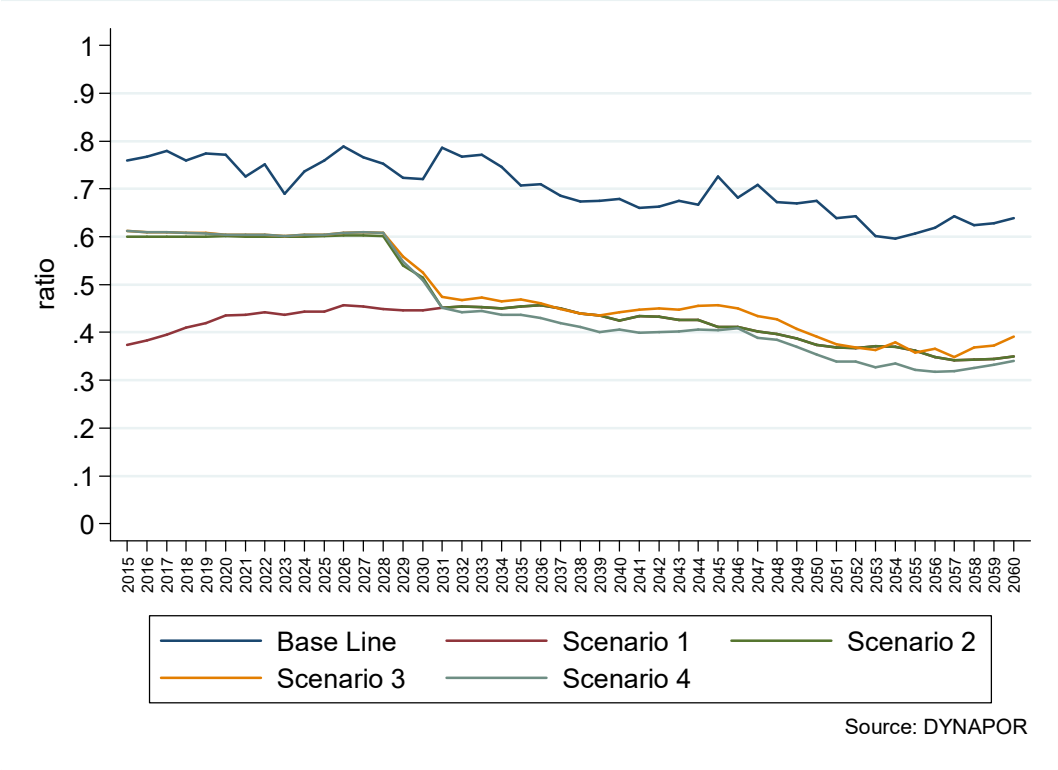
between pension systems is evident, with the baseline scenario displaying an initial benefit ratio considerably higher than the remaining NDC scenarios. In the baseline scenario, the benefit ratio starts and 44 percent and falls to approximately 33 percent in 2040 when it remains stable and finishes 35 percent in 2060, representing a fall of 20.2 percent. Out of all the scenarios, Scenario 1 is the only one that shows an expected increase in the benefit ratio, from 18 percent in 2015 to 24 percent in 2060, representing an increase of 28 percent. Once again, the introduction of a transition safeguard shows a clear improvement in the benefit ratio at the beginning of the simulation, with Scenario 2 showing a benefit ratio of 30 percent in 2015. However, similarly to the average old age pension amount, the effect of the transition safeguard gets diluted throughout the simulation, once again showing a converging trend between Scenarios 1 and 2, with Scenario 2 finishing with a benefit ratio of 24 percent in 2060. Finally, in Scenarios 3 and 4, the introduction of the minimum guaranteed pension raises the expected benefit ratio at the end of the simulation in comparison with Scenarios 1 and 2. As expected, Scenario 3 outperforms Scenario 4, since the introduction of the automatic balance mechanism decreases the indexation of the notional accounts for the years where there is a financial deficit.

Figure 41 Benefit Ratio projections, 2015-2060



With regards to the gross average replacement rate, *Figure 42* clearly shows a declining trend in all scenarios. The difference in generosity of the pension amount in relation to the last economic standpoint before retirement is evident between the NDC and the DB systems. The baseline scenario shows an expected decrease in the gross replacement ratio of 15.7 percent, from 0.76 in 2015 to 0.64 in 2060. Comparatively, the performance of the NDC scenarios is very limited. As expected, *Scenario 1* has the worst initial standpoint of all scenarios, showing a gross replacement rate of 0.36 in 2015 and 0.35 in 2060. *Scenarios 2, 3 and 4* all begin roughly around the 0.6 replacement rate, which reproduces the effect of the introduction of the transition safeguard. Although all scenarios decline similarly, Scenario 3 has the highest gross replacement ratio in 2060 with 0.39, followed by Scenario 2 with 0.35 and finally Scenario 4 with 0.34. It is noteworthy that the introduction of the automatic balance mechanism actually decreases the generosity of the system considerably, even if it is accompanied by the introduction of a minimum guaranteed pension.

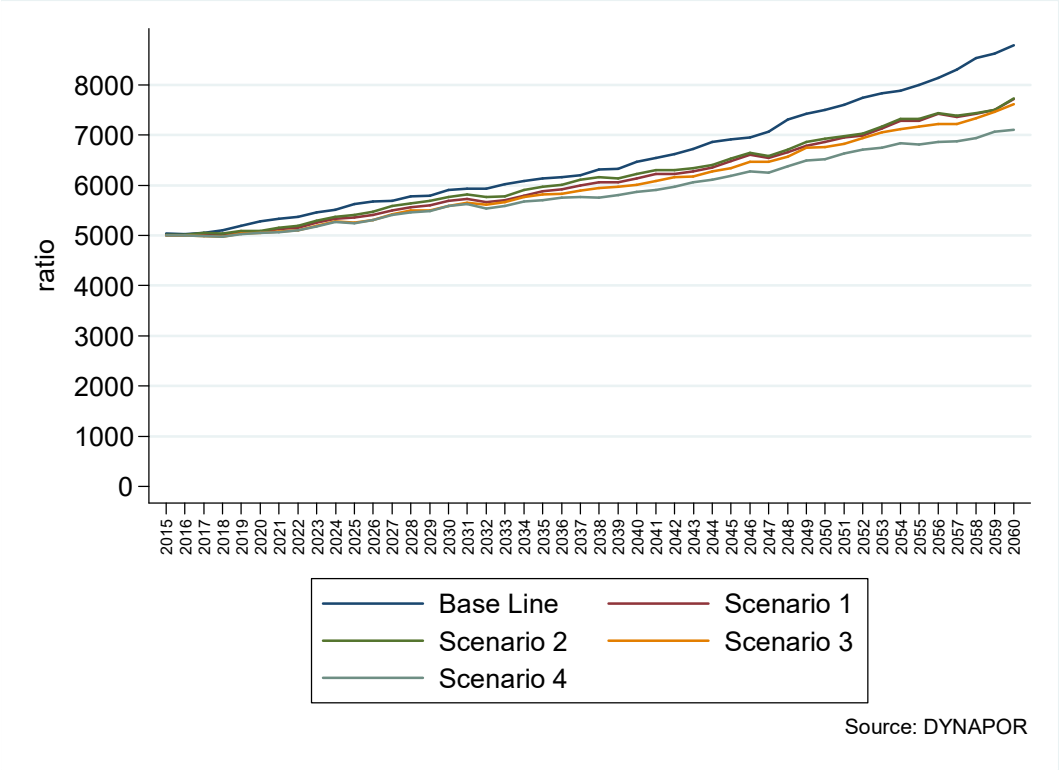
Figure 42 Gross Replacement Rate projections, 2015-2060



7.8. Prospective Poverty

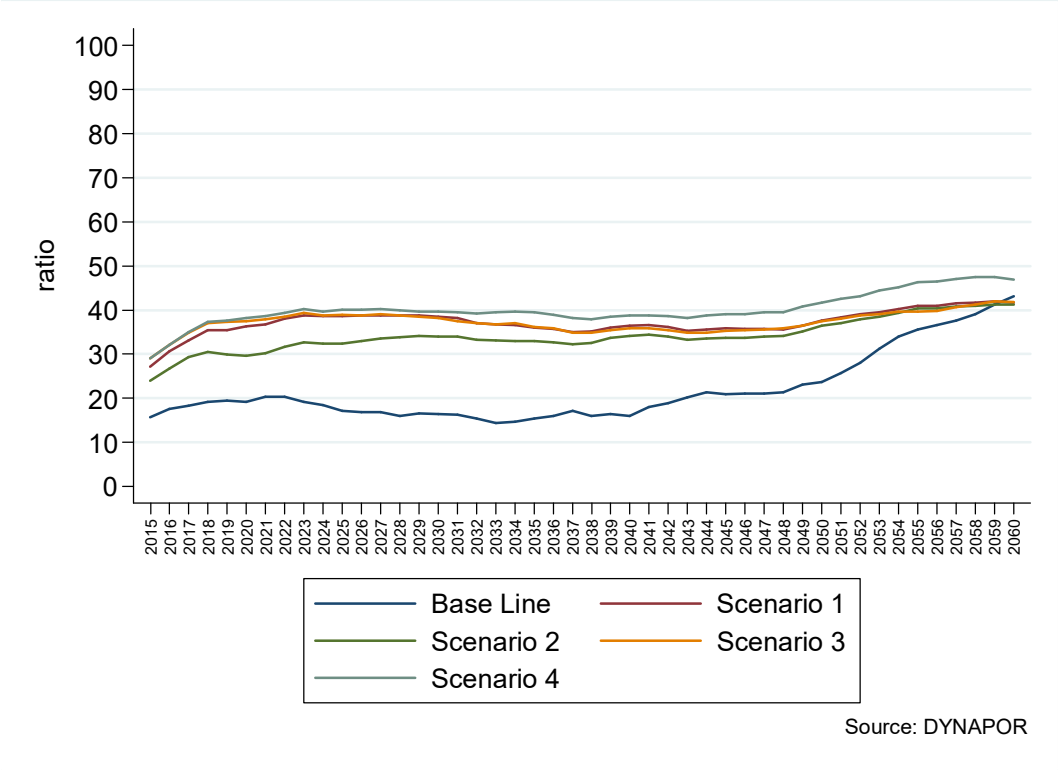
Regarding the analysis of poverty, this section takes an income threshold approach by defining the poverty threshold as 60 percent of median household income. The analysis begins by looking at the poverty incidence among pensioners in the various scenarios and proceeds by analysing inequality in the form of the Gini coefficient. With regards to the poverty threshold, all scenarios begin with a similar yearly amount of roughly 5 000 euros (*Figure 43*). The baseline scenario has the highest increase in the poverty threshold (from 5 032 euros in 2015 to 8 782 euros in 2060), followed by scenarios 1 and 2 (from roughly 5 000 euros in 2015 to 7713 euros in 2060), scenario 3 (from 4 994 euros in 2015 to 7 616 euros in 2060) and finally scenario 4 (from 4 994 euros in 2015 to 7 100 euros in 2060).

Figure 43 Poverty threshold projections, 2015-2060



After establishing the poverty line for each of the scenarios, it is now possible to determine the at-risk-of-poverty-rate, i.e. the rate of individuals that are below the poverty line against those that are above the poverty line. As shown in *Figure* 44 the at-risk-of-poverty-rate of old age pensioners in all scenarios increases. The baseline scenario shows an increase in the at-risk-of-poverty-rate (AROP) of pensioners from 15.71 percent in 2015 to 43.2 percent in 2060. On the other hand, Scenario 1 starts at an AROP of 27.23 percent in 2015 to 41.73 percent in 2060, while Scenario 2 shows an expected increase in the AROP of pensioners from 23.91 percent in 2015 to 41.17 percent in 2060. Scenario 3 shows an expected increase in the AROP of pensioners from 29.09 percent in 2015 to 41.8 percent in 2060. Finally, Scenario 4 shows an expected increase in the AROP of pensioners from 29.09 percent in 2015 to 46.9 percent in 2060. As shown, out of all scenarios, Scenario 4 appears to have the worst AROP of all in 2060. Again, the differences between the DB and the NDC scenarios is evident.

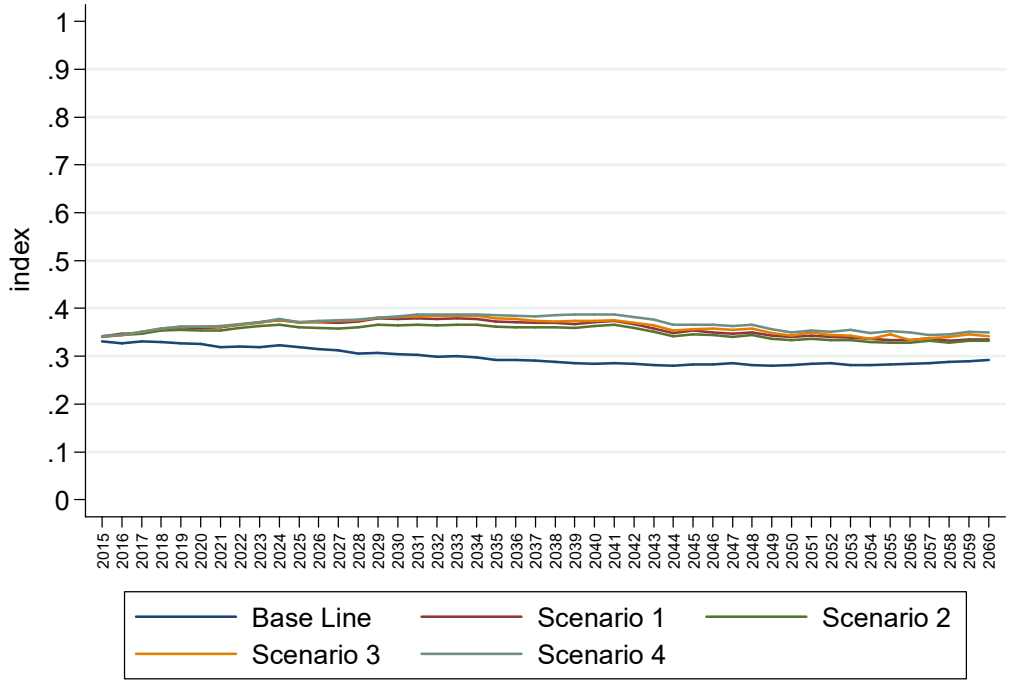
Figure 44 At-Risk-Of-Poverty Rate of pensioners projection, 2015-2060



Finally, Figure 45 shows the expected evolution of the Gini Index[18] for pensioners in the simulation. According to the results, the scenario that performs the best is the baseline scenario, with an actual decline in inequality among pensioners. Comparatively, all of the NDC scenarios show an actual increase in the levels of inequality during the first years followed by a gradual decline. It is important to note that in these scenarios, the difference between 2015 and 2060 is marginal.

[18] The gini coefficient is a measure of inequality initially developed by Corrado Gini in 1912. It consists of a ratio between 0 and 1 where 0 represents perfect equality, which means that everyone has the same exact income, and 1 represents perfect inequality, which means that one person has all the income in the economy (OECD, 2015).

Figure 45 Gini Index projections, 2015-2060



Source: DYNAPOR

Chapter 8: Discussion

8.1. Introduction

The purpose of this section is to summarize and discuss the theoretical and policy implications of the findings described in Chapter 7 in the light of the questions and hypothesis that have guided this thesis. In order to organize this discussion, I believe that a short reminder of the research questions is in order. This thesis has been developed in an attempt to answer a broad question: *what would be the impact of the introduction of a Notional Defined Contribution old age Pension System on the financial and social sustainability in Portugal*? In order to achieve this, 4 sub-questions were developed in order to breakdown this exercise into smaller parts. Consequently, each sub-question has led to a hypothesis that was tested in the previous chapters of this thesis. The questions and respective hypothesis of this thesis were the following:

5. Does the current Pension System in Portugal have a risk of financial instability due to exogenous factors such as demographic ageing?

H_1: The process of demographic ageing does not pose any threat to the sustainability of the current Pension System in Portugal.

6. Would a transition to a Notional Defined Contribution Pension System improve the financial sustainability of the pension system?

H_2: A transition to a Notional Defined Contribution System would significantly improve the financial sustainability of the Pension System in Portugal.

7. What would be the impact of a transition to a Notional defined Contribution scheme on the social sustainability and the adequacy of the pension system?

H_3: A transition to a Notional Defined Contribution System would worsen the adequacy and the social dynamics of the Pension System in Portugal.

8. Would a Notional Defined Contribution Scheme be better to ensure sustainability in light of exogenous factors, such as demographic ageing or slow economic growth, than the current Pension System in Portugal?

H_4: A transition to a Notional Defined Contribution System would ensure that demographic ageing and slow economic growth have no impact on the sustainability of the Pension System in Portugal.

8.2. Main Findings

This section will provide an overview of the major findings of this thesis and how they relate to other results in the field. With regards to the main question driving this thesis, the results of the simulations and subsequent answers to the sub-questions suggest that a transition to a NDC pension system in Portugal would significantly improve the financial sustainability of the pension system in Portugal, especially if it included design features such as an Automatic Balance Mechanism, that controls pension the indexation of notional accounts according to the financial situation of the system. Additionally, a transition to an NDC pension system, even with the introduction of the redistribution features covered here, such as a minimum pension amount or a transition safeguard, would have a considerable negative impact on the social dynamics of the pension system. The closer link between contributions and pensions, significantly affects the generosity of the system and increases inequality among pensioners. Finally, a striking finding of this thesis is that the introduction of redistributive measures do appear to have a significant impact on the long-term financial sustainability of the NDC pension system. In order to proceed with the discussion, this section will be separated into four parts, each pertaining to one of the sub-questions identified above.

8.2.1. Question 1: Does the current Pension System in Portugal have a risk of financial instability due to exogenous factors such as demographic ageing?

The quest for the answer to this question began with a description of the historical evolution of the Pension System in Portugal in Chapter 2. As shown, throughout the years there has been a range of expansionary policies that have increased both coverage and benefit levels of the pension system in Portugal. According to the Path Dependency Theory described in Pierson (2000), institutions and policies are sticky and once a government has gone down a path, it becomes costly and very difficult to reverse it. Additionally, past policies influence new policies by encouraging policy continuity.

Therefore, in order to understand the current situation of the Pension System in Portugal, it is imperative to have an understanding of its origins.

The analysis in Chapter 2 concludes that since its birth, the Portuguese Pension System has developed a wide range of reforms that have expanded the generosity of its system. This eventually led to a series of financial imbalances, which threatened the long-term sustainability of the system. Consequently, the last two decades have been characterized by a several pension reforms, mostly aimed at cutting back expenditure. Overall, most of these pension reforms were made through means of parametric adjustments. The number of parametric adjustments that took place over the years clearly demonstrates the lack in effectiveness of this kind of pension reform.

Additionally, in order to answer this question, Chapter 3 provides an overview of the prospective sustainability of the current and Pension System according to the results of the 2015 Ageing Report. As shown, the sustainability of the Pension System in Portugal is expected to be affected by exogenous factors. The projections of the 2015 Ageing Report assume a scenario of declining population characterized by population ageing. According to these projections, if no action is taken to account for the increase in the share of the elderly in relation to the working age population, there is an expected increase in both pension demand and expenditure. This is best illustrated in the form of the expected doubling of the Old-Age Dependency Ratio projections. If there are no changes to the system and the number of pensioners doubles in relation to the working age population, this essentially means that the ability of the system to finance its liabilities is cut by half. In addition, the analysis of the 2015 Ageing Report projections shows that the system is expected to lose some of its pension adequacy. Both Benefit-Ratios and Gross Replacement Ratios are expected to fall considerably between 2015 and 2060, showing a slight loss in the ability of the pension system to protect individuals against a loss of income in old age.

The DYNAPOR simulation results of the base line scenario, the scenario with the current pension system, are mostly aligned with the projections of the 2015 Ageing Report. Although there are extra

variables that can be used to characterize the situation. The quantitative analyses of the simulation results of the base line scenario in Chapter 6 clearly shows an expected increase in pension demand, which in turn, translates into an increase in expenditure. Additionally, as the system matures throughout the simulation, individuals begin to retire with more generous reforms as a result of increasing careers, adding to the overall expenditure of the system. Additionally, the base line results show a decline in the working age population and, consequently, on the financing of the Pension System. This translates into a considerable decline in the financial balance of the Pension System, which according to the DYNAPOR results is expected to run a yearly deficit of approximately 11 000 million euros by 2060.

With regards to adequacy, the results of the base line scenario show a decline in both benefit ratios and gross replacement ratios. However, it is important to note that the expected decline presented by the 2015 Ageing Report is much more accentuated than the results of DYNAPOR, which overall show an expected adequacy level above the one presented in the Ageing Report. Nonetheless, there is a downwards trend in terms of adequacy and an expected increase in poverty. These results appear to be in line with other projections and clearly rejects the first hypothesis of this thesis and shows that according to the ageing projections of the Ageing Report 2015, which serve as the Demographic dynamics for the DYNAPOR model, if the system remains unchanged there will be a considerable decline in the ability of the Pension System in Portugal to finance its obligations.

In light of these issues, policymakers may attempt to enhance the financial sustainability by either increasing Social Security contributions, shifting the burden to the working population, by decreasing pension generosity shifting the burden to pensioners or by a combination of the two. As explained in Bosworth and Burtless (2004), this essentially represents a zero-sum game.

8.2.2. Question 2: Would the Transition to an NDC scheme improve the financial sustainability of the pension system?

In order to tackle the second question, this thesis begins with an analysis of the NDC pension systems and their transitions. The first chapter of this thesis describes a standard NDC pension system and covers some of the pros and cons related to these systems. Additionally, Chapter 4 provides an in-depth analysis of the NDC systems in Italy, Poland and Sweden according to their types of transition and current sustainability. The analysis in Chapter 4 seems to suggest that each of the countries analysed appear to have different experiences as not all systems were designed and implemented in the same way. Countries that have proceeded to a faster phasing out of the previous system appear to have benefited more of the increase in financial sustainability that is often associated with a transition to a NDC pension system. However, the analysis in Chapter 4 appears to suggest that the introduction of an NDC pension system has significantly improved the financial balance of the pension system in Italy, Poland in Sweden.

The results of the simulation, presented in Chapter 7, appear to be in line with the conclusions drawn from Chapter 4. The introduction of a NDC pension system in Portugal appears to significantly improve the long-term sustainability of the pension system when compared to the projections of the current system. Additionally, it stresses the importance of the design features of the NDC pension systems, such as the Automatic Balance Mechanism (ABM). As show in section 7.5. of Chapter 7, the financial balance of the pension system improves substantially when the NDC pension system is introduced. All NDC scenarios have shown a considerable decline in the fiscal burden associated with population ageing. Additionally, the introduction of an ABM appears to bring the system to a positive balance in 2060. Finally, these results only hold if, similarly to the Swedish pension system, we assume that minimum pensions and the transition complement are financed via state transfers. Otherwise, this is not the case.

In order to quantify the impact of the introduction of a NDC pension system in Portugal, I have calculated the difference of the accumulated deficit between the baseline scenario and Scenario 4 (NDC with ABM). The deficit is calculated here as the difference in the contributions destined for old age pension expenditure and the expenditure with old age pensions. The results show that the introduction of a NDC pension system with an Automatic Balance Mechanism would result in savings upwards from 235 million euros by 2060. Please note that these savings do not include expenditure in redistributive measures, such as the minimum pension or the transition safeguard. If the expenditure with these measures is also included, the savings in terms of government transfers are relatively lower, representing approximately 182.5 million euros. This essentially confirms the hypothesis set out by this question, that a transition an NDC pension system would significantly improve the financial balance of the pension system in Portugal.

Overall, these results appear to be in-line literature on the topic. For example, in their analysis of NDC transitions, Lindeman, Robalino, & Rutkowski (2006) conclude that the introduction of NDC-type formulas can contribute to improve the financial sustainability of the Pension System in relation to traditional DB-PAYG schemes. Additionally, the importance of certain NDC design features that are essential to achieve this outcome, such as the ABM is evident. These results appear to fall in line with the work Chybalski (2015), which concludes that the Automatic Balance Mechanism is a very important tool in protecting the financial sustainability of NDC pension systems against uncertain events, such as population ageing for example. In line with these findings, it is clear to see that Scenario 4, the scenario where the ABM is introduced, outperforms all of the remaining scenarios in terms of financial sustainability. In fact, it is the only scenario to reach the end of the simulation with a positive balance.

8.2.3. Question 3: What would be the impact of a transition to a Notional Defined Contribution scheme on the Social Sustainability and adequacy of the pension system?

The following question that was identified in this thesis regards the impact of a transition to a NDC scheme on the Social Sustainability, Adequacy and Poverty distribution in the Portuguese Pension System. The results in Chapter 4 suggest that the Adequacy of the pension systems in the countries analysed has declined since the adoption of the NDC pension system, except for Italy. The simulation results of this thesis appear to be in line with the findings in Chapter 4. As shown in the analysis of Chapter 7, although a transition to an NDC pension system would improve the financial sustainability of the pension system, it would also have a negative impact on the social dynamics of the current pension system, such as social sustainability, adequacy and poverty for example.

First, the results show that the introduction of a NDC scheme immediately poses a considerable decline in the average pension amount for new pensioners. On this point, it is important to note that the transition methodology used to create the notional accounts may have magnified this result. In this thesis, I have used an instant transition to an NDC pension system. In his work, Palmer (2006) argues that an immediate transition has the advantage of breaking away from the old system immediately. It reduces the probability of the old system to generate more deficit, as all individuals that have not yet retired are immediately converted to the new system. The main advantage of this type of transition is that the advantages of the NDC system can be felt from the outset of the transition, which somewhat appears to add value to the answer to the previous question. However, there are some issues that may have resulted in an amplification of the effect of the reduction in the average pension amount. The first issue has to do with the imputation of reference earnings and contributory careers. The imputation of reference earnings and contributory careers was done with administrative data that had averages amounts according to age, gender and income group. Since the initial capital of the notional account is determined by multiplying the contributions, calculated as the product of the current contribution rate for Social Security by the reference earnings, by the number of years with contributions, any misrepresentation that is present in the averages imputed will have

an impact on the pension amount, especially during the first years of the simulation. This may explain the rapid growth in average pension amount that is shown in the NDC scenarios.

Overall the results regarding the social sustainability of the pension system, measured as the average pension amount, suggest that the introduction of an NDC pension scheme are expected to result in a sharp decline in the average pension amount when compared with the current DB-PAYG scheme. Additionally, the transition safeguard and the minimum pension amounts are paramount in curbing the initial drop in pension amount and improving the social sustainability of the pension system during the transition period.

With regards to pension adequacy, the results show that the current system clearly outperforms the NDC scenarios. Traditional DB-PAYG systems are more generous as the pensions are calculated by taking into account the best 10 out of the last 15 years of contributions or in other cases the best 40 out of the full career. Consequently, this type of scheme is better equipped to smooth individual income in their transition to retirement than its NDC counterpart.

Regarding poverty, the results of this thesis appear to suggest a converging trend between the current system scenario and the NDC scenarios. However, it is important to note that although the there is a convergence trend in the at-risk-of-poverty rate, the poverty lines for the scenarios are very different. Additionally, although there is a converging trend in the at-risk-of-poverty rate, with regards to inequality, the Gini Index clearly shows the impact of the stronger redistributive measures associated with the pension formula of the traditional DB-PAYG scheme. These findings are consistent with the results of Ruzik-Sierdzińska and Jarocinska (2015). In their work, the authors use a microsimulation model to analyse the distributional effects of the 1999 Polish reform. The authors conclude that the introduction a NDC system is expected to result in an increase in inequality in the future. Additionally, the authors identify the initial decrease in the initial capital as the source of this inequality.

It is important to note that, while the introduction of the minimum pension amount and the transition safeguard are essential in order to contain and limit the impact of the transition to an NDC on the

Social Sustainability, adequacy and poverty, its impact on the financial balance is limited. As shown in section 7.7. in Chapter 7, there are some differences in the financial balance of the pension system, however, all NDC scenarios, with the exception of Scenario 4 which has the ABM controlling expenditure, show a converging trend in the deficit. These results clearly show the importance of the system design. It is clear by this discussion of the results that without redistributive measures such as the ones used here (minimum pension amount or a transition safe-guard), the NDC falls short of the current DB-PAYG system in terms of the performance of social indicators of pensioners (average pension amount, benefit-ratio, gross replacement ratio and at-risk-of-poverty ratio). Additionally, the costs associated with the introduction of re-distributive measures do not appear to produce a long-term impact on the financial balance of the pension system.

The results of this thesis confirm the hypothesis set out by this question. Overall, the results of this thesis suggest that NDC pension systems are not as well equipped as traditional DB-PAYG systems to deal with issues of adequacy or poverty reduction. Even the scenarios that had a minimum pension and a transition safeguard performed considerably lower in all indicators, except for at-risk-of-poverty rate, than the current system. These findings are in line with the work of Davoine (2015), which concludes that while the introduction of a NDC pension system may provide a significate improvement in the financial sustainability of the pension system, it has poses a severe adverse effect on the distributional system's distributive properties. Additionally, the author argues that policymakers can combine pension and tax reforms to implement a NDC pension system without the adverse distributional impact.

8.2.4. Question 4: Would a Notional Defined Contribution scheme be better to ensure sustainability in light of exogenous factors than the current system?

The results of this thesis suggest that Notional Defined Contribution schemes are better than traditional DB-PAYG schemes in controlling the impact of increases in longevity. Additionally, the difference between scenarios, once again, stresses the importance of NDC system design in ensuring

that the system is implemented appropriately. The introduction of the Automatic Balance Mechanism produces a considerate effect in the ensuring the financial sustainability of the system. In fact, Knell (2016) argues that given the multiple sources for unpredictable shocks to the sustainability of the pension system, it seems inevitable that NDC systems include some additional mechanism that adjusts for unforeseen imbalances, such as the Swedish ABM for example.

Although the automatic balance mechanism and the very nature of NDC systems appears to mitigate the impact of population ageing on the financial balance of the pension system, they do not completely nullify it. Instead, population ageing is felt some other way. When the system is out of balance, the automatic balance mechanism is activated. Once this happens, the notional accounts are indexed to the balance index which always provides a lower rate than the usual income index. Consequently, although the automatic balance mechanism manages to protect NDC schemes against financial imbalances, it does so by lowering the pension indexation, which in turn results in lower pension amounts. Moreover, it affects the adequacy of the pension system. Therefore the hypothesis of this section is rejected.

8.3. Limitations

It is important to note that a Microsimulation Model is not a perfect representation of reality. Instead, there are several factors that are left out when developing a model of this kind.

The first refers to the fact that DYNAPOR does not have a migration module. The only way individuals can enter or leave the simulation are by being born or dying. Although it is no simple endeavour, the main reason of the lack of a migration module in DYNAPOR is not hardship, but instead the lack of available data to determine the characteristics of the migrants. The creation and deletion of individuals is simple in DYNAPOR, however, it is necessary to ensure that we delete the “right” individuals in the right proportions. Finally, since the purpose of the simulation was to enact some scenario comparison, since all scenarios are being run without a migration module, the impact of the lack of migration is evenly spread across scenarios and therefore it cancels each other out.

Chapter 9: Conclusion

The purpose of this thesis was to analyse the impact of a simulated transition to a NDC scheme on the Pension System in Portugal. The results suggest that even after two decades of parametric reforms and pension adjustments, there is still a deeply rooted sustainability problem in the Portuguese Pension System. Primarily, this issue lies on the inability of the pension system to adapt to changes in the structure of the population. Projections have shown that Portugal is one of the countries in Europe that is most likely to suffer due to the process of population ageing. As the Portuguese population will

age and shrink, there is a shortening of the contributory base that is currently used to finance the pension system. Hence, there is an aggravation of the financial sustainability of the pension system that results from two driving forces: first there is an increase in the number of pensioners; second there is a shortening of the contributory base that is used to cover old age pensions.

According to the results presented in this thesis it can be concluded that, if the pension system remains as it is, the strain that would have to be placed on the working age population would make it unsustainable. Additionally, while policymakers may attempt to propose a wide range of parametric reforms, these are only short term adjustments that are at best able to provide a temporary fix to the inherent issue of the Pension System in Portugal.

This thesis has shown that, under the assumptions of the DYNAPOR model, the introduction of a NDC pension system would provide a better long-term solution to the financial problem of the Portuguese Pension System. The tighter link between pensions and contributions would decrease pension expenditure and save millions in government transfers. Additionally, the importance of redistributive measures in the design of a NDC scheme is made evident. An NDC system without a minimum guaranteed pension, or some other means of safety-net against poverty, would primarily result in an inadequate pension system that would fail in its most basic of objectives: to provide income security in old age. Additionally, this thesis clearly illustrates the importance of the Automatic Balance Mechanism in equipping the pension system with the necessary tools to adjust to any shifts in the structure of the population or economic growth.

Overall, the results appear to be in line with the existing research on NDC, which in turn, also attests for the ability of Dynamic Microsimulation Models to perform in this type of exercise. Additionally, after a thorough review of the existing literature on modelling retirement behaviour, this thesis concludes that in order to model the retirement decision in NDC pension system simulation model, an option-value approach is best suited.

The results clearly point for the need of a systemic pension reform in Portugal. The inherent problem in dealing with exogenous factors is evident in the results of this thesis. While a system transition to a NDC scheme may be beneficial to the financial sustainability of the pension system, its impact on the social sustainability, adequacy and poverty is not positive. If at some point in time policymakers decide that there is a need to implement an NDC pension system, it is necessary to carefully design this model. As the results of this thesis have shown, the redistributive features of the system, such as a minimum pension is paramount in order to keep the NDC scheme in line with the objectives of a pension system.

Finally, there is still room for a wide range of analysis. The NDC system is not the only other type of system that exists. Other research options would be to simulate the transition to a system other than the NDC. These could include, but not be limited to, a fully funded system (FDC) or even a points system such as the one developed in Belgium for example. I believe that a comparative study regarding several types of systemic reforms would provide enable a better understanding of the impact of a systemic reform in the context of the Portuguese Pension System.

Appendix I: Systematic literature review of retirement behaviour

1. Objectives

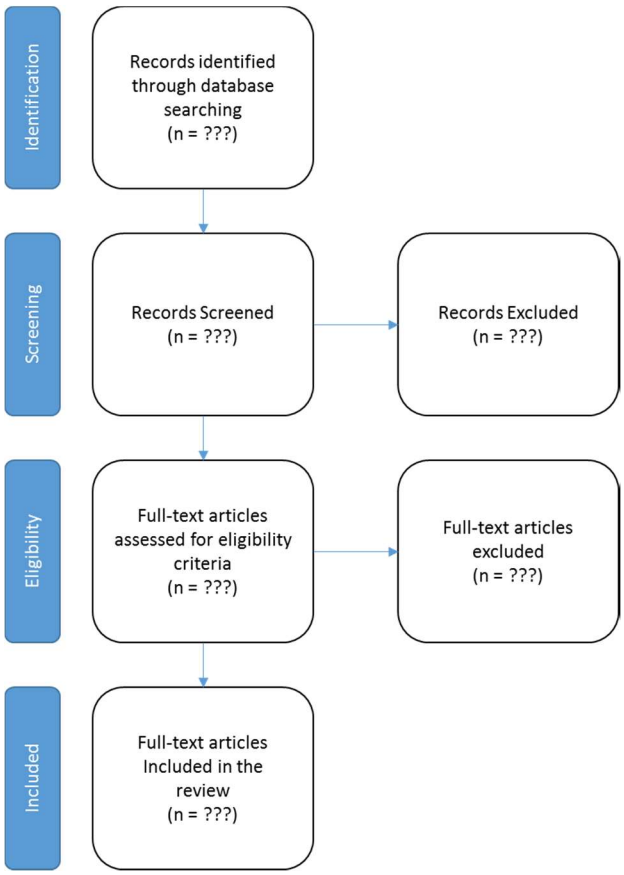
The objective is to systematically review studies regarding individual retirement behaviour in order to determine the best way to model individual retirement decision in a microsimulation model.

2. Methodology

Retirement behaviour has been modelled by using several strategies, each with its strengths and weaknesses. The purpose of this review is to identify the factors that influence retirement behaviour and the most suitable way to simulate this process in a microsimulation model. However, there is a

vast amount of literature regarding retirement behaviour that poses a variety of conceptual outcomes. In order to overcome this issue, it is necessary to limit the scope of our review in order to be as thorough as possible. Consequently, a series of eligibility criteria and screening processes were devised in order to filter the references according to their quality and level of suitability to answer the research questions of this work.

Figure 46 PRISMA methodology used in the review



Source Adapted from Moher et al. 2009

The methodology used for this literature review follows the PRISMA guidelines (Moher, Liberati, Tetzlaff, & Altman, 2009), and is best illustrated in *Figure 46* Following the general guidelines in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA), the methodology used in this review will consist of 3 steps. The first step consists of an identification process, consisting of a thorough search in various databases. The second step is an initial screening process that will exclude references that are not relevant to our study. Finally, the third step is an eligibility test where

the full-text of the articles is reviewed in order to exclude those that are not relevant. Each of the steps in this figure will be thoroughly described ahead.

3. Literature Search

The following indexing services were identified to conduct the identification process:

- Web of Science (https://webofknowledge.com/);

The search terms used for the search were the following:

Retirement behaviour, early retirement, retirement pension, take-up, old age pension, retirement, elderly, senior, pensioner, models of retirement, age of retirement, retirement attitude, pension allowance, timing of retirement, retirement planning, retirement simulation, retirement modelling.

Since some of these indexing services provide a wide range of research areas, we will limit the scope of our search to a few selected categories within the Social Sciences. It is important to note that these categories may differ from search engine to search engine, as a result it is necessary to analyse and select the categories in the Social Sciences field that are most relevant from each of the indexing services. For example, in the ISI Web of Knowledge I have identified the following categories for this search: *Behavioral Sciences, Mathematical Methods in Social Sciences, Sociology, Social Issues, Social Sciences Other Topics and Public Administration.* Consequently, only references that belong to one of these categories were included in the screening process.

4. Data Collection and Analysis

The screening and selection process of the studies to include in this literature review was done in a two-step process. Phase one of the screening process consisted of an analysis of the title and abstract of each of the references that were classified as “promote to next level”, “exclude” or “unsure”. References that were not classified as either “promote to next level” or “unsure” were excluded at phase one of the screening process. Additionally, in cases where the abstract and title are insufficient to assess the relevance of the reference to our analysis, the conclusion section was included in the

screening process. Finally, phase two of the screening process consisted of an analysis of the full text of each of the references that passed phase one of the screening process.

5. Eligibility Criteria

The study inclusion and exclusion criteria set the boundaries for the systematic literature review and must be carefully considered. They should be set after the research questions are defined and before the search is conducted. These criteria act as a form of triage that will narrow down the search to the only those studies that are relevant to answering the research questions initially set out. These criteria are often recorded as a table or a paragraph in the methodology selection. The inclusion/exclusion criteria of this review is recorded in the form of a table and it will focus on three different types of criteria: types of studies, types of participants and types of outcomes.

Inclusion Criteria
Types of Studies - English or Portuguese language; - Publication date: from 1990 to 2016; - OECD Countries; - Studies that attempt to simulate or model retirement behaviour at the individual level.

Exclusion Criteria
Types of Studies - Non English or Portuguese language; - Publication date before 1990; - Grey literature / Not published in a peer reviewed journal; - Studies from outside of the OECD; - Studies that use univariate approaches; - Studies that explore qualitative evidence; - Evidence reviews.

According to Reeves et al (Reeves, Koppel, Barr, Freeth, & Hammick, 2002), the process of inclusion and exclusion of references should be conducted by either two reviewers or a panel that discusses and decides on disagreements on what references meet the necessary criteria to be included in the review or not. In order to overcome this shortcoming, in this review, all of the references that do not fully meet the exclusion criteria were discussed with my thesis advisor.

Finally, there will be an additional screening of the bibliographies of the selected references.

6. Search Strategy

ISI Web of Knowledge

The search process for the ISI Web of Knowledge reference indexing service began with a broad search for references containing the terms searched.

Titles Searched: TI=(retirement+behavio*r OR early+retirement OR retirement+pension OR take-up OR old+age+pension OR retirement OR pensioner OR models+of+retirement OR age+of+retirement OR retirement+attitude OR pension+allowance OR timing+of+retirement OR retirement+planning OR retirement+simulation OR retirement+modelling)

Languages: (English)

This initial search returned 11 784 references. I proceeded by applying some of the initial inclusion / exclusion criteria that were defined. First, I considered only references published between 1990 and 2017. Second, I only considered Articles, Books or Book Chapters. Finally, I added Portuguese to the list of Languages.

Titles Searched: TI=(retirement+behavio*r OR early+retirement OR retirement+pension OR take-up OR old+age+pension OR retirement OR pensioner OR models+of+retirement OR age+of+retirement OR retirement+attitude OR pension+allowance OR timing+of+retirement OR retirement+planning OR retirement+simulation OR retirement+modelling)

Languages: (English OR Portuguese)

Type of Documents: (Article OR Book OR Book Chapter)

This second search returned 4 057 references. Finally, I proceed by limiting the scope in terms of research areas. In order to make this search more concise I wish to consider specific areas of research. For example, I do not wish to include references from the field of Psychology. Consequently, I limited the search to the following research fields: Economics, Applied Mathematics, Interdisciplinary Mathematics Applications, Political Science, Public Administration, Social Issues, Social Sciences Interdisciplinary, Social Sciences Mathematical Methods, Sociology and Statistics Probability. With the application of the search restriction to the research fields, the final search resulted in 1 162 references.

Titles Searched: TI=(retirement+behavio*r OR early+retirement OR retirement+pension OR take-up OR old+age+pension OR retirement OR pensioner OR models+of+retirement OR age+of+retirement OR retirement+attitude OR pension+allowance OR timing+of+retirement OR retirement+planning OR retirement+simulation OR retirement+modelling)

Languages: (English OR Portuguese)

Type of Documents: (Article OR Book OR Book Chapter)

Category Refinement: (POLITICAL SCIENCE OR PUBLIC ADMINISTRATION OR MATHEMATICS APPLIED OR MATHEMATICS INTERDISCIPLINARY APPLICATIONS OR SOCIAL ISSUES OR SOCIAL SCIENCES INTERDISCIPLINARY OR ECONOMICS OR SOCIAL SCIENCES MATHEMATICAL METHODS OR SOCIOLOGY OR STATISTICS PROBABILITY)

Appendix II: Baseline Scenario Projections

		2015	2020	2025	2030	2035	2040	2045	2050	2055	2060	% Change
Demographic Indicators	Population Percentage Change	-0.002	-0.003	-0.005	-0.005	-0.006	-0.007	-0.007	-0.008	-0.010	-0.011	
	Total Population$_1$	10.40	10.26	10.05	9.83	9.59	9.31	8.98	8.63	8.23	7.87	-0.244
	Population age 0 - 14$_1$	1.51	1.36	1.24	1.15	1.11	1.07	1.01	0.98	0.91	0.85	-0.435
	Population age 15 - 64$_1$	6.81	6.66	6.41	6.11	5.72	5.29	4.86	4.58	4.33	4.11	-0.395
	Population age 65+$_1$	2.09	2.24	2.41	2.57	2.77	2.95	3.10	3.07	2.99	2.90	0.390
	Demographic Dependency Ratio	0.53	0.54	0.57	0.61	0.68	0.76	0.85	0.88	0.90	0.91	0.727
	Old age dependency ratio	0.31	0.34	0.38	0.42	0.48	0.56	0.64	0.67	0.69	0.71	1.299
	Average Age (total)	45.23	46.55	47.67	48.46	49.14	49.71	50.30	50.73	51.02	51.14	0.131
Labour Force	Work age individuals (15-64)$_1$	6.81	6.66	6.41	6.11	5.72	5.29	4.86	4.58	4.33	4.11	-0.395
	Labour force total$_1$	4.83	4.75	4.58	4.41	4.21	3.99	3.77	3.59	3.45	3.33	-0.310
	Participation Rate (15-64)	70.82	71.16	71.19	71.89	73.19	74.91	76.76	77.80	78.98	79.80	0.127
	Males	73.97	72.92	72.56	72.75	74.43	75.96	77.94	78.53	79.40	81.38	0.100
	Females	67.84	69.46	69.87	71.06	71.99	73.89	75.58	77.08	78.54	78.21	0.153
	Employment Rate (15-64)	59.97	61.46	64.04	65.58	67.14	69.37	70.98	71.71	73.11	74.40	0.241
	Males	63.26	63.02	65.31	66.34	68.13	70.31	72.70	72.79	73.85	76.18	0.204
	Females	56.84	59.96	62.83	64.85	66.18	68.46	69.27	70.64	72.36	72.61	0.277
	Unemployment Rate (15-64)	10.85	9.70	7.15	6.31	6.05	5.54	5.78	6.09	5.87	5.40	-0.503

	Males	10.71	9.91	7.25	6.42	6.30	5.65	5.25	5.74	5.55	5.20	-0.514
	Females	11.00	9.50	7.04	6.20	5.81	5.43	6.32	6.44	6.19	5.60	-0.491
	Average labour force age (total)	41.49	42.14	42.03	41.77	41.76	41.90	42.24	42.51	43.04	43.20	0.041
Pension Demand	Total Pensioners$_2$	1897	1940	2175	2473	2751	2970	3012	3074	2912	2775	0.463
	Old age pensioners$_2$	1666	1692	1781	1902	2100	2251	2380	2483	2439	2403	0.442
	Early retired pensioners$_2$	106	53	172	323	398	468	381	353	261	158	0.496
	Early retired pensioners (LDU$_3$)$_2$	125	196	222	248	252	250	251	237	212	214	0.709
Expenditure	Total Expenditure$_4$	12384	12231	13684	16229	18564	21647	23719	26675	27630	28875	1.332
	Old Age DB$_4$	10800	11200	11900	13100	14600	16700	19500	22500	24600	26400	1.444
	Early Retired$_4$	873	349	1460	2790	3660	4510	3630	3620	2630	1680	0.924
	Early Retired (LDU)$_4$	711	682	324	339	304	437	589	555	400	795	0.118
Financial Balance	Contributions (total)$_4$	17600	19300	21600	23600	24900	26300	26800	27400	28900	30400	0.727
	Contributions (Old age)$_4$	10218	11217	12571	13742	14468	15277	15610	15948	16799	17677	0.730
	Financial Balance$_4$	-2215	-992	-1079	-2447	-4092	-6325	-8082	-10745	-10819	-11235	4.072
	Percentage of GDP	-1.29	-0.54	-0.54	-1.15	-1.82	-2.70	-3.33	-4.28	-4.16	-4.16	2.215
Social Sustainability	Average Old Age Pension$_5$	6409	6420	6484	6694	6768	7132	7826	8619	9620	10651	0.662
	Average Early Old-Age pension$_5$	7634	6405	8178	8469	9084	9273	9453	10177	10041	10699	0.402
	Average Early Old-Age pension (LDU)$_5$	6447	5476	5470	5918	5918	6825	8202	8209	7317	10600	0.644

Adequacy	Benefit Ratio	0.44	0.42	0.40	0.38	0.35	0.33	0.33	0.33	0.34	0.35	-0.202
	Gross Replacement Ratio	0.76	0.77	0.76	0.72	0.71	0.68	0.73	0.67	0.61	0.64	-0.157
Poverty	Poverty Threshold[5]	5032	5277	5619	5900	6131	6465	6909	7505	7992	8782	0.745
	At-risk-of-poverty Rate											
	65 years old and over	12.6	13.6	15.5	18.3	18.5	19.9	24.3	29.2	31.0	34.8	1.769
	old age pensioners	15.7	19.2	17.1	16.4	15.4	16.0	20.9	23.7	35.6	43.2	1.750

Source: DYNAPOR

1) in millions of individuals

2) in thousands of individuals

3) LDU: Long duration unemployment

4) in millions of euros

5) yearly amount

Appendix III: Scenario 1 Projections

		2015	2020	2025	2030	2035	2040	2045	2050	2055	2060	% Change
Demographic Indicators	Population Percentage Change	-0.002	-0.003	-0.005	-0.005	-0.006	-0.007	-0.007	-0.008	-0.010	-0.011	
	Total Population$_1$	10.40	10.26	10.05	9.83	9.59	9.31	8.98	8.63	8.23	7.87	-0.244
	Population age 0 - 14$_1$	1.51	1.36	1.24	1.15	1.11	1.07	1.01	0.98	0.91	0.85	-0.435
	Population age 15 - 64$_1$	6.81	6.66	6.41	6.11	5.72	5.29	4.86	4.58	4.33	4.11	-0.395
	Population age 65+$_1$	2.09	2.24	2.41	2.57	2.77	2.95	3.10	3.07	2.99	2.90	0.390
	Demographic Dependency Ratio	0.53	0.54	0.57	0.61	0.68	0.76	0.85	0.88	0.90	0.91	0.727
	Old age dependency ratio	0.31	0.34	0.38	0.42	0.48	0.56	0.64	0.67	0.69	0.71	1.299
	Average Age (total)	45.23	46.55	47.67	48.46	49.14	49.71	50.30	50.73	51.02	51.14	0.131
Labour Force	Work age individuals (15-64)$_1$	6.80	6.64	6.40	6.10	5.70	5.29	4.87	4.58	4.38	4.15	-0.389
	Labour force total$_1$	4.82	4.75	4.63	4.49	4.27	4.03	3.77	3.58	3.43	3.28	-0.318
	Participation Rate (15-64)	70.70	71.07	71.78	72.85	73.94	75.19	76.32	77.38	77.45	78.07	0.104
	Males	74.10	73.59	75.04	76.19	77.82	79.05	79.30	80.74	81.11	80.20	0.082
	Females	67.48	68.65	68.64	69.59	70.14	71.40	73.31	74.02	73.79	75.91	0.125
	Employment Rate (15-64)	59.67	61.03	64.56	66.41	67.53	69.44	70.90	71.56	71.83	72.44	0.214
	Males	63.17	62.99	67.22	69.26	71.26	73.30	74.04	75.10	75.95	75.42	0.194
	Females	56.35	59.13	62.00	63.63	63.88	65.65	67.72	68.02	67.69	69.44	0.232

	Unemployment Rate (15-64)	11.03	10.05	7.21	6.44	6.41	5.75	5.42	5.82	5.63	5.62	-0.490
	Males	10.92	10.60	7.81	6.94	6.57	5.75	5.26	5.64	5.16	4.78	-0.562
	Females	11.13	9.52	6.64	5.96	6.27	5.75	5.59	6.00	6.10	6.47	-0.419
	Average labour force age (total)	41.47	42.19	42.26	42.15	42.04	42.07	42.20	42.58	42.87	42.93	0.035
Pension Demand	Total Pensioners (DB + NDC)$_2$	1866.2	1775.9	1963.4	2218.6	2458.0	2650.1	2796.3	2814.0	2813.6	2682.0	0.437
	Old age pensioners NDC$_2$	71.9	296.5	735.9	1253.8	1735.3	2111.6	2385.9	2512.2	2553.0	2459.1	33.208
	Old age pensioners DB$_2$	1583.1	1291.8	1052.6	773.2	523.0	339.2	223.5	143.4	118.4	91.4	-0.942
	Early retired pensioners DB$_2$	105.5	40.6	6.0	2.2	0.9	0.6	0.0	0.0	0.0	0.0	-1.000
	Early retired pensioners (LDU$_3$) DB$_2$	105.6	146.9	168.9	189.4	198.8	198.7	186.9	158.4	142.2	131.6	0.245
Expenditure	Total Expenditure (DB + NDC)$_4$	11979	10099	10337	11591	13486	15760	17380	18689	19128	19477	0.626
	Old Age NDC$_4$	202	1130	3530	7000	10600	14000	16400	18200	18800	19100	93.554
	Old Age DB$_4$	10300	8180	6430	4270	2540	1410	668	236	118	16	-0.998
	Early Retired DB$_4$	870	248	28	8	3	2	0	0	0	0	-1.000
	Early Retired (LDU) DB$_4$	607	541	349	313	343	348	312	253	210	361	-0.405
Financial Balance	Contributions (total)$_4$	17300	18700	21300	23400	24900	26100	27000	27500	28300	28900	0.671
	Contributions (Old age)$_4$	10041	10896	12367	13596	14474	15203	15684	15993	16487	16835	0.677
	Financial Balance$_4$	-1975	798	2030	2012	941	-522	-1696	-2716	-2599	-2596	0.315
	Percentage of GDP	-1.15	0.43	1.01	0.94	0.42	-0.22	-0.70	-1.08	-1.00	-0.96	-0.167

Social Sustainability	Average Old Age Pension (DB + NDC)$_5$	6313	5911	5772	5771	6008	6372	6627	6931	7021	7396	0.172
	Average Old-Age pension (NDC)$_5$	2707	3673	4642	5380	5883	6317	6612	6933	7014	7378	1.726
	Average Old-Age pension (DB)$_5$	6408	6431	6583	6439	6439	6778	6899	7497	8732	4426	-0.309
Adequacy	Benefit Ratio	0.18	0.24	0.28	0.30	0.29	0.29	0.27	0.26	0.24	0.24	0.280
	Gross Replacement Ratio	0.37	0.43	0.45	0.45	0.45	0.44	0.42	0.38	0.36	0.35	-0.064
Poverty	Poverty Threshold$_5$	4995	5057	5352	5694	5876	6140	6480	6860	7287	7713	0.544
	At-risk-of-poverty Rate											
	65 years old and over	15.97	21.07	28.96	35.77	38.29	39.48	39.90	41.69	44.11	45.93	1.875
	old age pensioners	27.23	36.25	38.69	38.47	36.06	36.43	35.84	37.57	40.90	41.73	0.532

Source: DYNAPOR

1) in millions of individuals

2) in thousands of individuals

3) LDU: Long duration unemployment
4) in millions of euros
5) yearly amount

Appendix IV: Scenario 2 Projections

		2015	2020	2025	2030	2035	2040	2045	2050	2055	2060	% Change
Demographic Indicators	Population Percentage Change	-0.002	-0.003	-0.005	-0.005	-0.006	-0.007	-0.007	-0.008	-0.010	-0.011	
	Total Population$_1$	10.40	10.26	10.05	9.83	9.59	9.31	8.98	8.63	8.23	7.87	-0.244
	Population age 0 - 14$_1$	1.51	1.36	1.24	1.15	1.11	1.07	1.01	0.98	0.91	0.85	-0.435
	Population age 15 - 64$_1$	6.81	6.66	6.41	6.11	5.72	5.29	4.86	4.58	4.33	4.11	-0.395
	Population age 65+$_1$	2.09	2.24	2.41	2.57	2.77	2.95	3.10	3.07	2.99	2.90	0.390
	Demographic Dependency Ratio	0.53	0.54	0.57	0.61	0.68	0.76	0.85	0.88	0.90	0.91	0.727
	Old age dependency ratio	0.31	0.34	0.38	0.42	0.48	0.56	0.64	0.67	0.69	0.71	1.299
	Average Age (total)	45.23	46.55	47.67	48.46	49.14	49.71	50.30	50.73	51.02	51.14	0.131
Labour Force	Work age individuals (15-64)$_1$	6.80	6.64	6.40	6.10	5.70	5.29	4.87	4.58	4.38	4.15	-0.389
	Labour force total$_1$	4.82	4.75	4.63	4.49	4.27	4.03	3.77	3.58	3.43	3.28	-0.318
	Participation Rate (15-64)	70.70	71.07	71.78	72.85	73.94	75.19	76.32	77.38	77.45	78.07	0.104
	Males	74.10	73.59	75.04	76.19	77.82	79.05	79.30	80.74	81.11	80.20	0.082
	Females	67.48	68.65	68.64	69.59	70.14	71.40	73.31	74.02	73.79	75.91	0.125
	Employment Rate (15-64)	59.67	61.03	64.56	66.41	67.53	69.44	70.90	71.56	71.83	72.44	0.214
	Males	63.17	62.99	67.22	69.26	71.26	73.30	74.04	75.10	75.95	75.42	0.194
	Females	56.35	59.13	62.00	63.63	63.88	65.65	67.72	68.02	67.69	69.44	0.232

	Unemployment Rate (15-64)	11.03	10.05	7.21	6.44	6.41	5.75	5.42	5.82	5.63	5.62	-0.490
	Males	10.92	10.60	7.81	6.94	6.57	5.75	5.26	5.64	5.16	4.78	-0.562
	Females	11.13	9.52	6.64	5.96	6.27	5.75	5.59	6.00	6.10	6.47	-0.419
	Average labour force age (total)	41.47	42.19	42.26	42.15	42.04	42.07	42.20	42.58	42.87	42.93	0.035
Pension Demand	Total Pensioners (DB + NDC)$_2$	1866.2	1775.9	1963.4	2218.6	2458.0	2650.1	2796.3	2814.0	2813.6	2682.0	0.437
	Old age pensioners NDC$_2$	71.9	296.5	735.9	1253.8	1735.3	2111.6	2385.9	2512.2	2553.0	2459.1	33.208
	Old age pensioners DB$_2$	1583.1	1291.8	1052.6	773.2	523.0	339.2	223.5	143.4	118.4	91.4	-0.942
	Early retired pensioners DB$_2$	105.5	40.6	6.0	2.2	0.9	0.6	0.0	0.0	0.0	0.0	-1.000
	Early retired pensioners (LDU$_3$) DB$_2$	105.6	146.9	168.9	189.4	198.8	198.7	186.9	158.4	142.2	131.6	0.245
Expenditure	Total Expenditure (DB + NDC)$_4$	12100	10459	11037	12651	14486	16560	18080	19289	19428	19577	0.618
	Old Age NDC$_4$	323	1490	4230	8060	11600	14800	17100	18800	19100	19200	58.443
	Old Age DB$_4$	10300	8180	6430	4270	2540	1410	668	236	118	16	-0.998
	Early Retired DB$_4$	870	248	28	8	3	2	0	0	0	0	-1.000
	Early Retired (LDU) DB$_4$	607	541	349	313	343	348	312	253	210	361	-0.405
Financial Balance	Contributions (total)$_4$	17300	18700	21300	23400	24900	26100	27000	27500	28300	28900	0.671
	Contributions (Old age)$_4$	10041	10896	12367	13596	14474	15203	15684	15993	16487	16835	0.677
	Financial Balance$_4$	-2096	440	1335	950	-57	-1399	-2429	-3252	-2920	-2743	0.308
	Percentage of GDP	-1	0	1	0	0	-1	-1	-1	-1	-1	-0.171

Social Sustainability	Average Old Age Pension (DB + NDC)[5]	6377	6111	6142	6272	6449	6744	6922	7152	7156	7454	0.169
	Average Old-Age pension (NDC)[5]	4373	4852	5569	6190	6447	6736	6924	7160	7150	7437	0.700
	Average Old-Age pension (DB)[5]	6408	6431	6583	6439	6439	6778	6899	7497	8732	4426	-0.309
Adequacy	Benefit Ratio	0.30	0.31	0.34	0.34	0.32	0.31	0.29	0.27	0.25	0.24	-0.202
	Gross Replacement Ratio	0.60	0.60	0.60	0.45	0.45	0.44	0.42	0.38	0.36	0.35	-0.416
Poverty	Poverty Threshold[5]	5006	5093	5406	5770	5969	6221	6524	6924	7314	7727	0.543
	At-risk-of-poverty Rate											
	65 years old and over	15.63	19.79	27.33	33.78	35.75	38.08	38.35	40.67	43.68	45.44	1.907
	old age pensioners	23.91	29.70	32.42	34.00	32.92	34.17	33.72	36.44	40.33	41.17	0.722

Source: DYNAPOR

1) in millions of individuals

2) in thousands of individuals

3) LDU: Long duration unemployment

4) in millions of euros

5) yearly amount

Appendix V: Scenario 3 Projections

		2015	2020	2025	2030	2035	2040	2045	2050	2055	2060	% Change
Demographic Indicators	Population Percentage Change	-0.002	-0.003	-0.005	-0.005	-0.006	-0.007	-0.007	-0.008	-0.010	-0.011	
	Total Population$_1$	10.40	10.26	10.05	9.83	9.59	9.31	8.98	8.63	8.23	7.87	-0.244
	Population age 0 - 14$_1$	1.51	1.36	1.24	1.15	1.11	1.07	1.01	0.98	0.91	0.85	-0.435
	Population age 15 - 64$_1$	6.81	6.66	6.41	6.11	5.72	5.29	4.86	4.58	4.33	4.11	-0.395
	Population age 65+$_1$	2.09	2.24	2.41	2.57	2.77	2.95	3.10	3.07	2.99	2.90	0.390
	Demographic Dependency Ratio	0.53	0.54	0.57	0.61	0.68	0.76	0.85	0.88	0.90	0.91	0.727
	Old age dependency ratio	0.31	0.34	0.38	0.42	0.48	0.56	0.64	0.67	0.69	0.71	1.299
	Average Age (total)	45.23	46.55	47.67	48.46	49.14	49.71	50.30	50.73	51.02	51.14	0.131
Labour Force	Work age individuals (15-64)$_1$	6.80	6.64	6.40	6.10	5.70	5.29	4.87	4.58	4.38	4.15	-0.389
	Labour force total$_1$	4.81	4.75	4.63	4.51	4.27	4.04	3.78	3.59	3.43	3.29	-0.316
	Participation Rate (15-64)	70.56	71.05	71.75	73.05	73.95	75.40	76.43	77.39	77.46	78.13	0.107
	Males	74.10	73.59	75.04	76.19	77.82	79.05	79.30	80.74	81.11	80.20	0.082
	Females	67.22	68.59	68.60	70.00	70.15	71.82	73.54	74.04	73.80	76.04	0.131
	Employment Rate (15-64)	59.54	61.00	64.57	66.58	67.54	69.65	70.98	71.60	71.85	72.47	0.217
	Males	63.17	62.99	67.22	69.26	71.26	73.30	74.04	75.10	75.95	75.42	0.194
	Females	56.10	59.07	62.01	63.97	63.91	66.07	67.89	68.09	67.75	69.49	0.239
	Unemployment Rate (15-64)	11.03	10.05	7.19	6.47	6.40	5.75	5.45	5.79	5.60	5.66	-0.486

	Males	10.92	10.60	7.81	6.94	6.57	5.75	5.26	5.64	5.16	4.78	-0.562
	Females	11.12	9.52	6.59	6.02	6.24	5.75	5.65	5.95	6.05	6.55	-0.411
	Average labour force age (total)	41.44	42.18	42.25	42.18	42.08	42.10	42.22	42.58	42.87	42.95	0.036
Pension Demand	Total Pensioners (DB + NDC)$_2$	1880.3	1777.1	1951.7	2204.9	2440.7	2630.5	2796.1	2809.3	2804.0	2667.9	0.419
	Old age pensioners NDC$_2$	85.9	297.7	724.2	1240.1	1718.0	2092.0	2388.9	2510.3	2550.3	2453.8	27.549
	Old age pensioners DB$_2$	1583.1	1291.8	1052.6	773.2	523.0	339.2	223.5	143.4	115.0	87.5	-0.945
	Early retired pensioners DB$_2$	105.5	40.6	6.0	2.2	0.9	0.6	0.0	0.0	0.0	0.0	-1.000
	Early retired pensioners (LDU$_3$) DB$_2$	105.6	146.9	168.9	189.4	198.8	198.7	183.7	155.6	138.7	126.5	0.198
Expenditure	Total Expenditure (DB + NDC)$_4$	12038	10058	10245	11541	13470	15731	17458	18752	19111	19429	0.614
	Old Age NDC$_4$	223	1090	3440	6950	10600	14000	16500	18300	18800	19100	84.650
	Old Age DB$_4$	10300	8180	6430	4270	2540	1410	671	235	119	16	-0.998
	Early Retired DB$_4$	870	248	28	8	3	2	0	0	0	0	-1.000
	Early Retired (LDU) DB$_4$	607	541	349	313	344	348	277	228	228	330	-0.456
Financial Balance	Contributions (total)$_4$	17200	18600	21200	23200	24500	25800	26800	27200	28300	28600	0.663
	Contributions (Old age)$_4$	10000	10800	12400	13500	14300	15000	15600	15800	16400	16600	0.660
		-					-	-	-	-	-	
	Financial Balance$_4$	2012.21	758.00	2109.83	1961.42	784.93	716.21	1892.63	2935.80	2679.59	2822.14	0.403
	Percentage of GDP	-1.17	0.41	1.05	0.92	0.35	-0.31	-0.78	-1.17	-1.03	-1.04	-0.111

Social Sustainability	Average Old Age Pension (DB + NDC)$_5$	6282	5885	5746	5786	6012	6418	6675	6975	7020	7373	0.174
	Average Old-Age pension (NDC)$_5$	4363	5033	5747	6533	6931	7474	7894	8368	8655	9226	1.114
	Average Old-Age pension (DB)$_5$	6408	6431	6583	6439	6438	6778	6925	7429	8806	4425	-0.309
Adequacy	Benefit Ratio	0.30	0.33	0.35	0.36	0.35	0.34	0.32	0.31	0.30	0.29	-0.012
	Gross Replacement Ratio	0.36	0.44	0.45	0.46	0.45	0.44	0.44	0.39	0.37	0.35	-0.044
Poverty	Poverty Threshold$_5$	4994	5052	5255	5588	5811	6006	6344	6763	7166	7616	0.525
	At-risk-of-poverty Rate											
	65 years old and over	15.93	21.26	27.60	34.32	38.10	38.41	38.71	41.29	43.22	45.76	1.874
	old age pensioners	29.09	37.46	38.87	38.13	36.22	35.83	35.32	37.47	39.72	41.80	0.437

Source: DYNAPOR

1) in millions of individuals

2) in thousands of individuals

3) LDU: Long duration unemployment

4) in millions of euros

5) yearly amount

Appendix VI: Scenario 4 Projections

		2015	2020	2025	2030	2035	2040	2045	2050	2055	2060	% Change
Demographic Indicators	Population Percentage Change	-0.002	-0.003	-0.005	-0.005	-0.006	-0.007	-0.007	-0.008	-0.010	-0.011	
	Total Population$_1$	10.40	10.26	10.05	9.83	9.59	9.31	8.98	8.63	8.23	7.87	-0.244
	Population age 0 - 14$_1$	1.51	1.36	1.24	1.15	1.11	1.07	1.01	0.98	0.91	0.85	-0.435
	Population age 15 - 64$_1$	6.81	6.66	6.41	6.11	5.72	5.29	4.86	4.58	4.33	4.11	-0.395
	Population age 65+$_1$	2.09	2.24	2.41	2.57	2.77	2.95	3.10	3.07	2.99	2.90	0.390
	Demographic Dependency Ratio	0.53	0.54	0.57	0.61	0.68	0.76	0.85	0.88	0.90	0.91	0.727
	Old age dependency ratio	0.31	0.34	0.38	0.42	0.48	0.56	0.64	0.67	0.69	0.71	1.299
	Average Age (total)	45.23	46.55	47.67	48.46	49.14	49.71	50.30	50.73	51.02	51.14	0.131
Labour Force	Work age individuals (15-64)$_1$	6.80	6.64	6.40	6.10	5.70	5.29	4.87	4.58	4.38	4.15	-0.389
	Labour force total$_1$	4.81	4.75	4.63	4.50	4.28	4.04	3.78	3.59	3.44	3.30	-0.314
	Participation Rate (15-64)	70.56	71.05	71.75	72.98	74.00	75.40	76.44	77.43	77.52	78.42	0.111
	Males	74.10	73.59	75.04	76.19	77.82	79.05	79.30	80.74	81.11	80.20	0.082
	Females	67.22	68.59	68.60	69.84	70.26	71.82	73.55	74.12	73.92	76.62	0.140
	Employment Rate (15-64)	59.54	61.00	64.57	66.52	67.58	69.68	70.99	71.62	71.91	72.73	0.222
	Males	63.17	62.99	67.22	69.26	71.26	73.30	74.04	75.10	75.95	75.42	0.194
	Females	56.10	59.07	62.01	63.85	63.98	66.12	67.90	68.15	67.87	70.03	0.248

	Unemployment Rate (15-64)	11.03	10.05	7.19	6.46	6.42	5.73	5.45	5.80	5.60	5.68	-0.485
	Males	10.92	10.60	7.81	6.94	6.57	5.75	5.26	5.64	5.16	4.78	-0.562
	Females	11.12	9.52	6.59	6.00	6.28	5.70	5.65	5.97	6.05	6.59	-0.408
	Average labour force age (total)	41.44	42.18	42.25	42.18	42.09	42.10	42.22	42.56	42.86	42.97	0.037
Pension Demand	Total Pensioners (DB + NDC)$_2$	1880.3	1777.1	1951.7	2207.3	2448.8	2627.0	2780.4	2815.9	2802.8	2664.0	0.417
	Old age pensioners NDC$_2$	85.9	297.7	724.2	1242.5	1726.0	2088.6	2373.1	2516.9	2549.2	2449.9	27.504
	Old age pensioners DB$_2$	1583.1	1291.8	1052.6	773.2	523.0	339.2	223.5	143.4	115.0	87.5	-0.945
	Early retired pensioners DB$_2$	105.5	40.6	6.0	2.2	0.9	0.6	0.0	0.0	0.0	0.0	-1.000
	Early retired pensioners (LDU$_3$) DB$_2$	105.6	146.9	168.9	189.4	198.8	198.7	183.7	155.6	138.7	126.5	0.198
Expenditure	Total Expenditure (DB + NDC)$_4$	12038	10024	10106	11230	12644	14081	15551	16454	16083	16380	0.361
	Old Age NDC$_4$	223	1060	3300	6640	9750	12300	14600	16000	15700	16000	70.749
	Old Age DB$_4$	10300	8180	6430	4270	2540	1410	671	235	119	16	-0.998
	Early Retired DB$_4$	870	248	28	8	3	2	0	0	0	0	-1.000
	Early Retired (LDU) DB$_4$	607	541	349	313	345	349	277	226	227	326	-0.463
Financial Balance	Contributions (total)$_4$	17200	18600	21200	23300	24700	26200	26900	27300	28300	28500	0.657
	Contributions (Old age)$_4$	10000	10800	12400	13500	14300	15200	15700	15900	16400	16600	0.660
	Financial Balance$_3$	-2012.21	791.38	2249.40	2319.16	1699.99	1130.86	113.16	-550.97	349.55	196.29	-1.098
	Percentage of GDP	-1.17	0.43	1.12	1.09	0.76	0.48	0.05	-0.22	0.13	0.07	-1.062

Social Sustainability	Average Old Age Pension (DB + NDC)$_5$	6282	5866	5673	5640	5632	5749	5951	6129	5874	6198	-0.013
	Average Old-Age pension (NDC)$_5$	4363	4976	5650	6390	6577	6935	7371	7807	7939	8507	0.950
	Average Old-Age pension (DB)$_5$	6408	6431	6583	6439	6438	6778	6925	7429	8807	4425	-0.309
Adequacy	Benefit Ratio	0.18	0.23	0.27	0.29	0.27	0.25	0.24	0.23	0.20	0.20	0.126
	Gross Replacement Ratio	0.61	0.60	0.61	0.46	0.43	0.40	0.41	0.37	0.32	0.34	-0.444
Poverty	Poverty Threshold$_5$	4994	5049	5236	5582	5705	5864	6181	6511	6806	7100	0.422
	At-risk-of-poverty Rate											
	65 years old and over	15.93	21.31	27.81	35.28	39.79	40.53	41.92	44.69	48.70	49.84	2.129
	old age pensioners	29.09	38.25	40.10	39.63	39.49	38.77	39.13	41.61	46.26	46.90	0.612

Source: DYNAPOR

1) in millions of individuals

2) in thousands of individuals

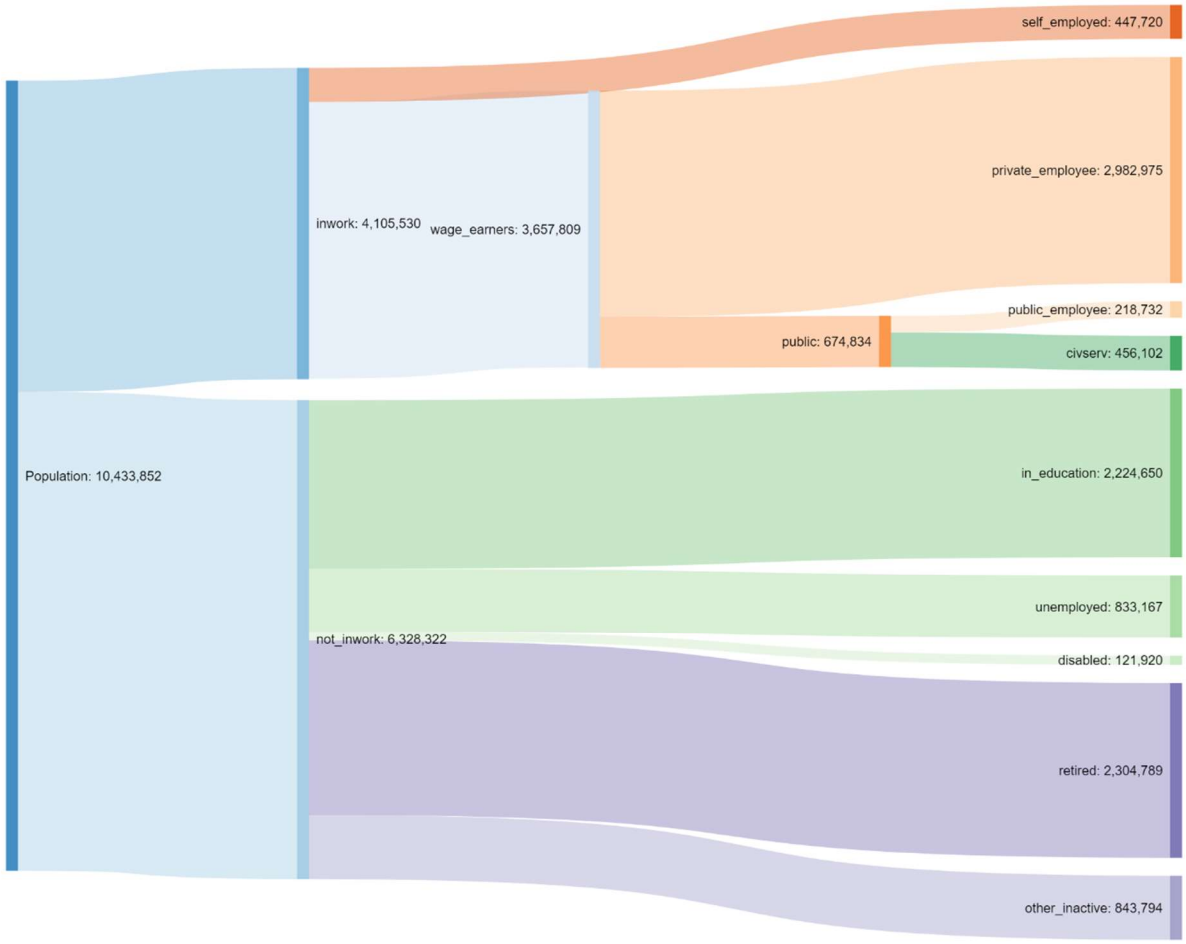
3) LDU: Long duration unemployment

4) in millions of euros

5) yearly amount

Appendix VII: Labour market simulation in DYNAPOR

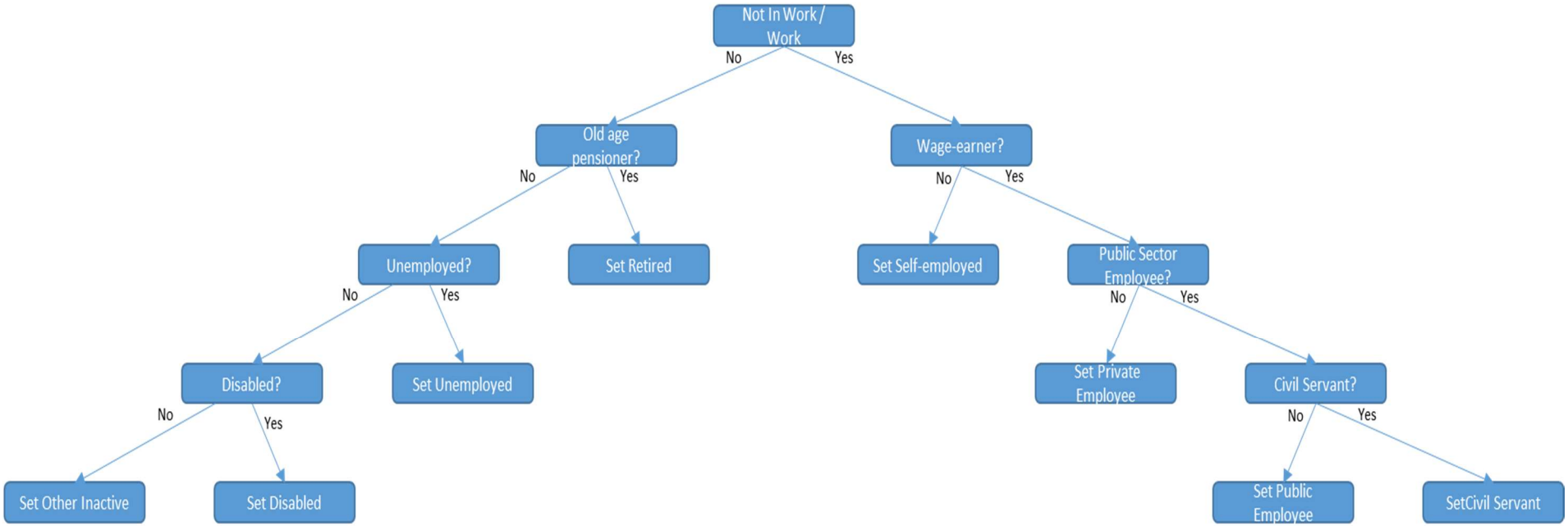
Figure 47 Labour Market Sankey Diagram of DYNAPOR



This appendix shows a graphical representation of how the labour market works in the DYNAPOR model. As shown, the population is first split into those in work and those not in work. This split is made by applying the proportions that are found in the alignment tables. Additionally, the split takes certain characteristics into account that follow the underlying assumptions of the model. For example, individuals that were civil servants in the previous year will either be civil servants in the current year or will be set as retired. All of these transitions and limitations are incorporated into the eligibility criteria for each of the alignment processes and have been thoroughly validated. After the work / not in work process, we proceed by identifying the wage earners from the individuals that were selected to be in work. Those that are in work and were not selected as wage earners are automatically set as self-employed. From the wage earners, we align those that work for the public sector (public

employees and civil servants). Those that have been characterized as wage earners but were not selected by the public sector alignment are automatically set as private employees. Finally, those that were selected by the public alignment are alignment by the public employee table. Those that were not selected by the public employee table, are set as civil servants.

Out of those that were not selected to be in work, individuals that receive an old age pension are automatically set as retired. Those that were not set as retired are aligned by the unemployment table. Those that were not selected by the unemployment table will be aligned by the disabled table. Finally, those that were not selected by the disabled table are set as other inactive. The decision tree along with the alignment code is found in the next figure.




```
- wage_earner: if(ACTIVEAGE and inwork,
                  align(wage_earner_score,
                        1 - (AL_SELF_EMPLOYED / (AL_ACTIVE_POP - AL_UNEMPLOYED)),
                        take=(lag(CIVSERV) or lag(EMPLOYEE_PUBLIC)) and ACTIVEAGE and inwork),
                  False)
```

```
- unemp: if(ACTIVEAGE and not WORKING,
            align(unemp_score,
                  AL_UNEMPLOYED / (AL_POPULATION - (AL_ACTIVE_POP - AL_UNEMPLOYED)),
                  leave = (INEDUCATION or ALL_OAP or DISABLED or oap_er_unemp) and ACTIVEAGE and not WORKING),
            False)
```

```
- public: if(ACTIVEAGE and wage_earner,
              align(public_score,
                    (AL_PUBLIC_EMPLOYEE + AL_CIVIL_SERVANT) / ((AL_ACTIVE_POP - AL_UNEMPLOYED) - AL_SELF_EMPLOYED),
                    take=(lag(CIVSERV) or lag(EMPLOYEE_PUBLIC)) and ACTIVEAGE and wage_earner),
              False)
```

```
- disab: if(ACTIVEAGE and not WORKING and not UNEMPLOYED,
            align(disab_score,
                  AL_DISABLED / (AL_POPULATION - AL_ACTIVE_POP),
                  leave=(lag(INEDUCATION) or ALL_OAP or lag(CIVSERV) or INEDUCATION or lag(ALL_OAP)
                        or oap_er_unemp) and ACTIVEAGE and not WORKING),
                  False)
```

```
- public_employee: if(ACTIVEAGE and public,
                      align(pe_score,
                            AL_PUBLIC_EMPLOYEE / (AL_PUBLIC_EMPLOYEE + AL_CIVIL_SERVANT),
                            leave=(lag(CIVSERV) and ACTIVEAGE and public)),
                      False)
```

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